POWER PLANT ENGINEERING

Established Over 34 Years

VOL. XXXIV CHICAGO, OCTOBER 1, 1930 No. 19

EDITORIAL STAFF — ARTHUR L. RICE, Editor; R. E. TURNER, Managing Editor; A. W. KRAMER, Associate Editor; CHESTER R. EARLS, Associate Editor; RICHARD H. MORRIS, Associate Editor; EDWARD J. KUNES, Associate Editor

Contents of this Issue

	Page
Power for the American Enka Corp.	1088
Steam Tunnels at the University of Wisconsin	1092
Switchboard and Controller Installed in Six Hours	1095
Veterans of the Power Plant Complete Twenty-Seven Years' Service Together	1096
Improving Industrial Heat Cycles. By W. F. Ryan	1097
Instrument Arrangement in Modern Power Plants	1098
New Boiler Plant for Slatersville Finishing Co.	1099
Low Diesel Operating Costs. By Harry J. Achee	1100
Smoke Abatement Progress. By Victor J. Azbe	1102
George Westinghouse Memorial to Be Dedicated	1104
Electricity—What It Is and How It Acts. By A. W. Kramer	1105
The Industrial Switchboard of Today. By Alfred C. Finney	1109
Saving the Heat in Boiler Blowdowns. By M. D. Dawson	1113
Operation and Maintenance of Ammonia Compressors. By C. T. Baker	1114
Program for 5th Midwest Power Engineering Conference	1117
Hydroelectric System of the City of Kaukauna, Wis.	1119
Air Compressor Lubrication. By H. L. Kauffman	1120
Checks on Rotating Electrical Apparatus. By A. C. Roe	1123
Factors Involved in the Selection of Pumps	1124
Soft Metal Hammer	1126
Longer Life for Chain Drives. By Charles R. Weiss	1127
Letters Direct from the Plant: Overcoming Trouble with Stoker Pusher Rods. How to Locate Faulty Fuses on Three-Phase Motors. Power Pole Installation on Rock Surface. Lead Not Necessary in Slow Speed Engines. Condenser Fouling Prevented by Chlorine.	1128
Questions and Answers: Calculation of Double Butt-Strap Joint. Remedy for Excitation Loss. Furnace Construction for Natural Gas. Acid Removal of Lime Deposits	1130
Editorial Comment: The Value of Automatic Hydroelectric Plants. Cash Dividends of Quiet Hours	1132
Off Duty	1133
Cleveland Welcomes N.A.P.E. Convention	1134
Full Voltage Motor Starter	1137
Dry Rectifier Replaces M-G. Set in Switching Equipment	1137
Automatic Ratio Control	1138
Multi-Port Valve for 125 Lb. Pressure	1138
Twin 16-In. Unit Heater	1139
Pneumatic Ash Removal	1139
Types NA-3 and NA-4 Acetylene Generators	1139
Electric Drive for Coal and Ash Gates	1140
Bridge Wall Seal	1140
Lombard Automatic Starter	1141
Self-Lubricating Bearing Metal	1141
Multi-V-Drive	1142
Balanced Venturi Reducing Valve	1142
New Design of Timestarter	1142
Flush-Mounted Gages	1143
New Automatic Stoker	1143
National Exposition of Power and Mechanical Engineering	1144
Small Pipe Machine	1144
Battledeck Floor Construction	1144
News Notes	1145
Books and Catalogs	1145
Power Plant Construction News	1146

Published on the 1st and 15th of each Month by the

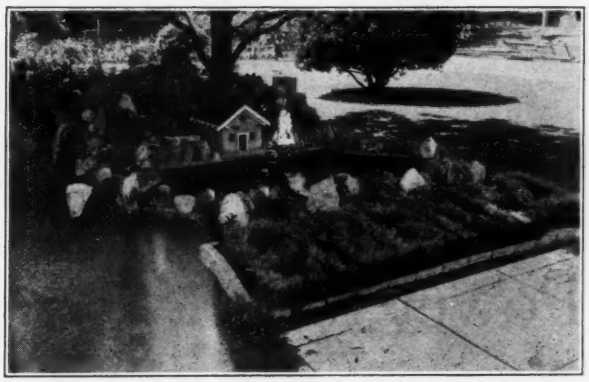
Technical Publishing Co., 53 West Jackson Blvd., Chicago

New York Office, 171 Madison Avenue

Subscription price $2.00 a year in the United States and possessions. Canada $2.75 a year. Other countries $3.50 a year. Single copies 15 cents.
Copyright 1930, by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Member, Associated Business Papers, Audit Bureau of Circulations.

Circulation of this issue 23,450



Electric Plant Thrives in Rock Garden

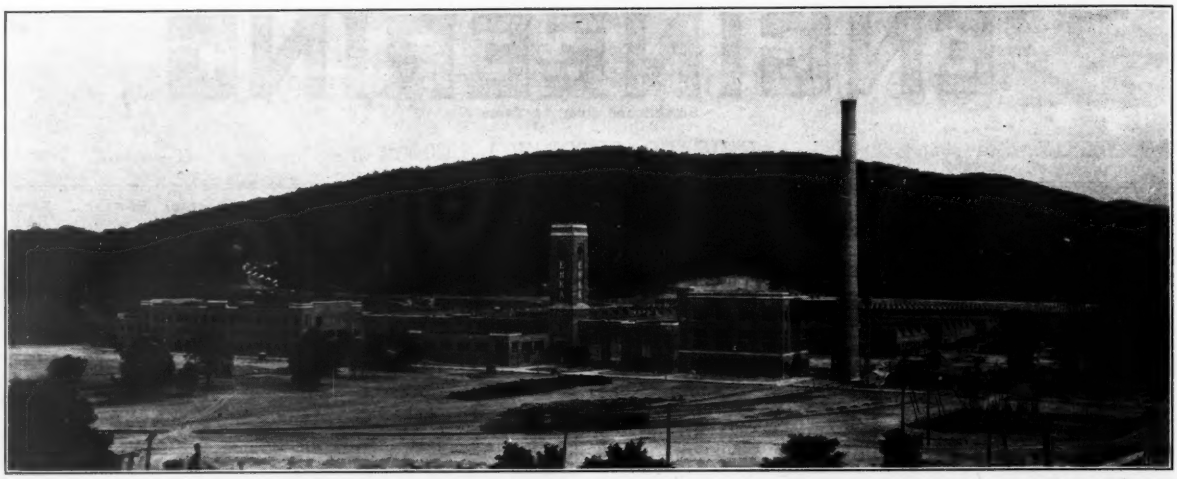
AMONG ALL the plants developed by the skill of man, probably none thrives better in rocky surroundings than the electric plant when properly nourished with water. To the hydraulic engineer it has, in its natural habitat, not only beauty but fascination, for to him it represents the connecting link between the wilderness and civilization, the wastefulness of nature turned into service of man, science at work with rocks and water.

What more fitting plant could be placed in a California rock garden? So evidently thought the crew at Engine Four of the Fresno, California, fire department whose interesting garden appears above.

The garden covers an area of about 100 sq. ft. and includes a power house, penstock line, reservoir, forebay, conduit, ditches, bridges, roads, transmission lines and operator's residence, on a setting built up in miniature just as it would appear in an ideal power location.

Details are carried out with minute care, the five transmission towers being in exact proportion to their gigantic originals. In the power house is a humming dynamo, and the discharge pipe spills realistically into a miniature lake. The hillsides are studded with trees of mountain varieties while trucks and cars are seen on the winding roads. The bridges are technically correct in structure and the purling streams over which they cross are banked with grass and ferns causing one almost to wish the scene were not miniature.

But engineers do not need to wish in vain for full size hydroelectric plants to admire where nature has piled the rocks and man implanted industry as has been done in Wisconsin, the location of the Kaukauna Hydroelectric Plants described on page 1118 of this issue. Here the engineers are not satisfied with only one use of the water but they put it to work three times before the stream is considered a sufficiently peaceful playmate for the contented cows that have made Wisconsin famous.



New 4400 kw. plant near Ashville, N. C. contains modern equipment designed for 350 lb. pressure, 700 deg. temperature.

Power for the American Enka Corporation

By P. P. Kriek*

DESIGN OF THE new power plant of the American Enka Corp. at Enka, N. C., near Asheville, was largely governed by the factory requirements for process steam and water. Continuous service, without even momentary interruptions, is of such vital importance to a rayon factory that efficiency, though not neglected, was considered second to reliability of service.

Steam is used in the process and for heating at 15 to 20 lb. pressure. It was estimated that in bleeding steam at this pressure from turbines, an average balance would be reached. With a nearly constant electric load all the year round and a variable steam load due to heating requirements, the steam load is greater in winter than required by the electric load, while in the summer the reverse may be the case. This latter fact, together with the desire to have an emergency supply of electricity, led to a contract with the local public utility and a certain minimum electric load is constantly drawn from this source.

Referring to the plan of the power house, attention is drawn to the arrangement of the single row of boilers at right angles to the row of turbines.

Considering the size of boilers chosen and considering also that, in order to meet the maximum demand of steam for process and for heating in winter the ratio of boiler horsepower to installed turbine horsepower is extremely high, it is seen that a single row of boilers would be much longer than the corresponding row of turbines. The arrangement shown was adopted, because a 100 per cent extension can be made by adding another row of boilers facing the existing ones and can be served from same overhead coal bunker and weigh larry. The turbine room can also be extended in the same direction as the boiler room, thus providing for a balanced plant of twice the present capacity.

*Chief Engineer, American Enka Corp., Enka, N. C.

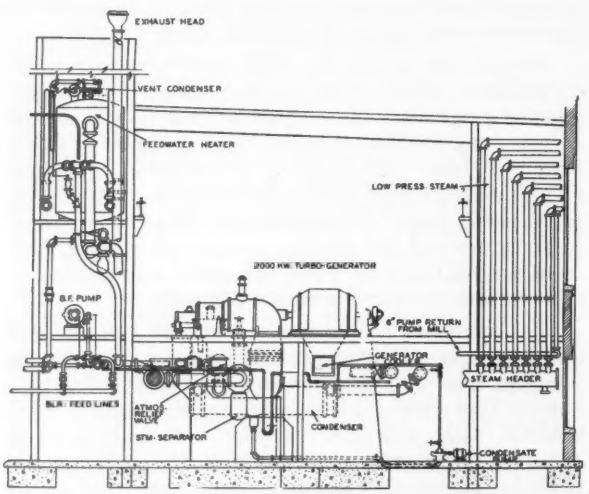


FIG. 1. GENERAL CROSS-SECTION THROUGH TURBINE ROOM, SHOWING PIPING RUNNING TO FACTORY THROUGH PIPE BRIDGE

Boiler House Equipment

The boiler house contains four 500-hp. vertical bent-tube boilers, with superheaters, designed for 350 lb. working pressure 275 deg. F. superheat. They are each fired by a five-retort underfeed stoker driven by a four-speed 3-phase induction motor, which with the two-speed gear drive on the stoker gives eight speeds. Furnaces are of refractory construction with carborundum brick along the slag line. Full automatic stoker control is provided with complete metering equipment. Two fans

driven by synchronous motors, each delivering 55,000 c.f.m., supply forced draft for the stokers, which are designed to operate the boilers at 200 per cent of rating continuously, 250 per cent for 4 hr. and 300 per cent maximum.

Two 250-g.p.m. and one 110-g.p.m. 4-stage motor-driven centrifugal pumps supply feedwater to the boilers and a steam pump of the marine type is kept as a standby. Feedwater is heated to about 160 deg. by exhaust steam in a feedwater heater of the open type, having a capacity of 135,000 lb. an hour.

Provisions for Pipe Expansion

High-pressure steam lines are arranged to give ample room for expansion. The way this has been accomplished is shown clearly on the plan; the main steam connection from the boiler stop valve to the line is S-shaped and the service connections between the two main steam headers are made at 45 deg. angle for the same reason. As no steam mains are visible, the turbine room presents a neat appearance.

Coal is unloaded from bottom-dump railroad cars into a pit equipped with crusher and is elevated by a bucket elevator to the top of the coal tower. Then it is either conveyed by a belt conveyor to the bunker inside the boiler house, or through a chute onto the outdoor coal pile, where it is handled by a dragline scraper.

The factory uses water either from a 300,000,000-gal. lake, formed by a dam in Moore's Creek Valley, or from Hominy Creek which partly encircles the factory. The lake, in addition to its natural supply, can be filled by pumping from the Hominy Creek. All of the water for the factory is chemically treated and filtered and flows to a pit in the powerhouse to be used as condenser circulating water. The condenser discharge is returned to the filter plant and then pumped to the service lines of the factory. It is also possible to cool the condensers with raw water directly from the lake by gravity. A separate raw-water line is provided for the fire pumps which are located in the powerhouse. There is also a connection to the city water system of Asheville. It follows from the above that water is available from three independent sources and power from two independent sources.

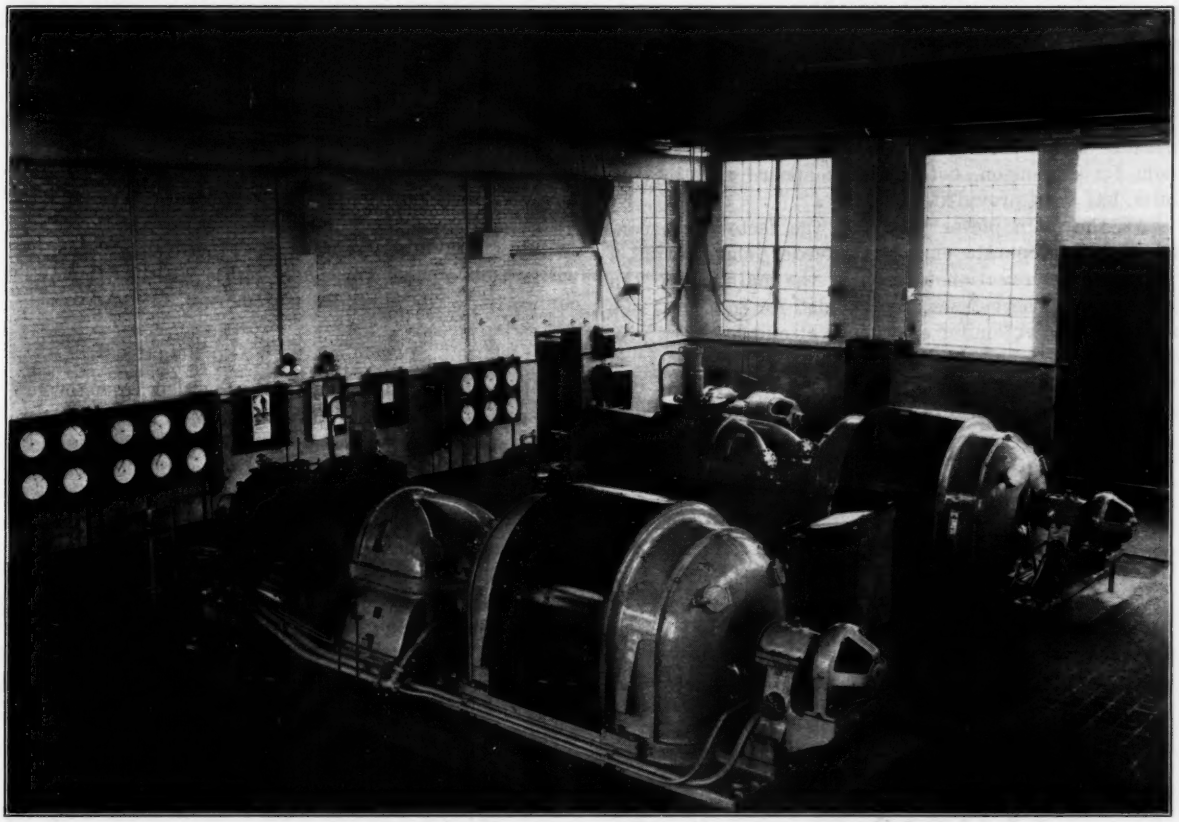


FIG. 2. TWO 2200-KW. EXTRACTION TURBINE GENERATORS SUPPLY POWER AND STEAM FOR PROCESS AND HEATING

The turbine room houses two 2200-kw. turbine generators running at 3600 r.p.m., furnishing current at 550 v., three-phase, 60 cycles. As mentioned before, they are of the extraction type, steam being bled at about 18 lb. pressure. The electric power is distributed directly from the main switchboard in the turbine room to the distributing panels in the factory. All motors over one horsepower are wound for 550 v. A number of motors over 50 hp. are of the synchronous type to help the power factor. In actual operation, about 15 per cent of the total load is carried by these motors, while occasionally they are used as synchronous condensers by disconnecting them from the driven unit and over-exciting their fields. The electricity for lighting is stepped down

to 110 v. at distributing points about the factory. Each bank of lighting transformers has another small set of 32-v. transformers, giving a 32-v. network throughout the factory to be used for portable lamps. This is a valuable safety measure, particularly in a factory where several floors are more or less wet most of the time.

Electrical Equipment

The main switching equipment consists of two sets of bus bars; one for the generators in the turbine room and the other for the outside supply. The main oil switches for these buses are located at the ground floor in a compartment which also houses the field rheostats for the generators, the storage battery, motor generator and regulator for the auxiliary direct current used to operate the oil switches and the constant current transformers for the street lighting system of the factory grounds. Each outgoing feeder has a relay-operated oil switch and disconnect switches to each of the bus systems. For housing the conduits, advantage has been taken of the pipe bridge which serves to enclose the low-pressure steam lines running to the factory. Ample room for expansion, both on switchboard and in conduits, has been provided.

All the main power panels in the factory are connected by a separate emergency feeder, constituting a ring with a connection to each of the main buses. In this manner, emergencies are provided for in a most economical way. A similar emergency circuit has been provided for the lighting installation. Changing from normal to emergency power feeder is done by hand disconnects while the failure of supply in a lighting feeder causes the emergency feeder to be switched on automatically, giving light from a separate lighting system of restricted output. Hand switches serve the purpose of supplying the emergency lights with current from the normal feeders for watchmen in rooms outside of regular working hours, but this system does not interfere with the regular function of the automatic throw-over switches. In other words, failure of a normal feeder will switch on the emergency lights whether they were connected to the normal circuit or not.

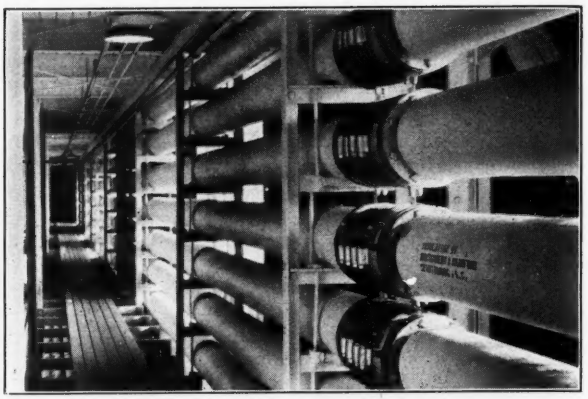


FIG. 4. STEAM LINES AND ELECTRICAL CONDUIT IN PIPE BRIDGE

Turbines Supply Heating and Process Steam

Steam for heating and process is bled from the low-pressure stages of the turbines. Any excess requirement is taken care of by a make-up installation, fed directly from each of the two high-pressure headers, consisting of two pressure reducing regulators and an automatically controlled desuperheater. Two low-pressure steam headers each have room for seven outgoing 8-in. steam lines. The powerhouse is built separately from the main manufacturing building and the steam lines are carried over in the all-inclosed elevated corridor or pipe bridge. Corrugated expansion joints are used. Both the high-pressure and the low-pressure steam lines are equipped with recording flow meters, keeping the entire system under continuous control.

Plans for the factory, including the powerhouse, were prepared by Lockwood Greene Engineers, Inc., of New York City, in close coöperation with the chief designing engineer of the Dutch Enka, J. W. Lubberhuizen and

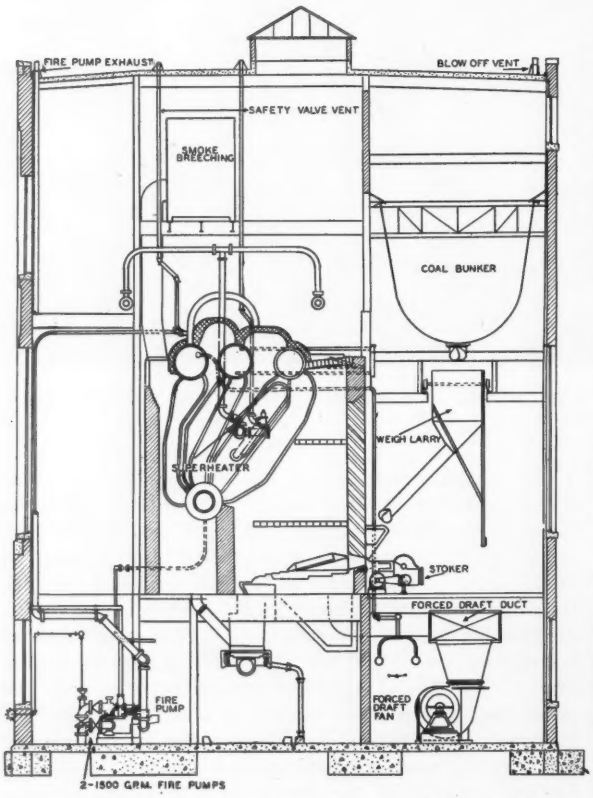


FIG. 3. GENERAL CROSS-SECTION THROUGH BOILER ROOM

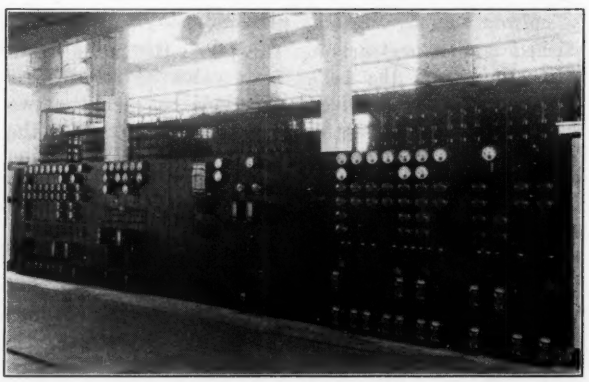


FIG. 5. MAIN SWITCHBOARD IN TURBINE ROOM

Principal Equipment in Power Plant of American Enka Corp.

BOILERS—4: Babcock & Wilcox Co. Type: Stirling Class XXI, three steam drums and one mud drum; 507 hp., 5066 sq. ft. heating surface; 350 lb. working pressure, 700 deg. F. final temperature; Copes feedwater regulators; Reliance gage columns; Diamond soot blowers; Yarway blowoff valves; Consolidated safety valves; B. & W. superheaters.

STOKERS: Riley Stoker Corp. Five retorts each, Super type, with air zones; width 9 ft. 2 in., inside length 11 ft. 3 in., active grate area 97.5 sq. ft.; drive: Two-speed gear and by chain through four-speed Louis Allis induction motor, 7½ hp. operated by controllers and primary relays.

ASH HOPPERS: Beaumont Manufacturing Co.; suspended type, vitrified shale brick lined, hydraulically-operated ash gates, two to each boiler.

BOILER CONTROL: Smoot Engineering Corp.; automatic control provided for: coal fed to each boiler to suit load, air damper in outlet to suit load, stoker windbox dampers to give constant pressure in combustion chambers.

SMOKE BREECHING: Connery & Co., Inc.

CHIMNEY: Alphons Custodis Chimney Construction Co. Height 250 ft., top diameter 11 ft.

DRAFT FANS—2: Buffalo Forge Co.; double-inlet, turbo-conoidal type; air capacity, 55,000 c.f.m. at 6 in. static pressure, driven by 100-hp. synchronous motors, unity p.f., co-axial exciters.

COAL HANDLING EQUIPMENT: Wilbur G. Hudson Corp.; storage capacity, 6000 t.; dragline scraper, 40 t. per hour; bucket ⅝ yard, Link-Belt Co.; track hopper has 24 by 24-in. crusher; elevator 40 t. per hour, speed 98 ft. a minute; belt conveyor to bunker 16 in., 50 t. per hour at 250 ft. a minute; capacity of overhead bunker, 150 t. per boiler.

TURBINE GENERATORS—2: Allis-Chalmers Mfg. Co.; current characteristics, 550 v., 60 cycles, a.c., 3-phase, 3600 r.p.m.; capacity of turbine, 2500 kw.; main generator at 0.8 p.f., 2200 kw.; maximum bled steam at 2000 kw. load, 15 lb. pressure, 40,000 lb.; total steam consumption under these circumstances, 45,000 lb. an hour. Air coolers: Griscom-Russell Co. Field rheostat motor operated; exciters on extended generator shaft, 125 v., 100 amp.

MOTOR-GENERATOR SET—1: Allis-Chalmers Mfg. Co.; 50 kw., 125 v., 2 wire; driven by 75-hp., 1165-r.p.m. induction motor.

CONDENSERS—2: Westinghouse Electric & Mfg. Co. Type: Surface, one pass, straight flow; effective surface, 2750 sq. ft. Equipped with a compound Leblanc steam jet air pump built on surface type inter and after cooler. Condensate pumps (three) centrifugal type, 100 g.p.m., 124 ft. total head.

BOILER FEED PUMPS: DeLaval Steam Turbine Co. Two 4-stage, 1800 r.p.m., 250-g.p.m. pumps, 873 ft. head, driven by 125-hp. synchronous motor. One 4-stage, 1750-r.p.m., 110-g.p.m. pump, 873 ft. head, driven by 60-hp. induction motor.

STEAM FEED PUMP: One, for standby and firing up, Worthington Pump & Machy. Corp. vertical duplex, 50 g.p.m., 7½ by 4½ by 10 in.

HOTWELL PUMPS: Nash Engineering Co. Two 300-g.p.m. pumps, 110 ft. total head.

VACUUM PUMPS—2: Chicago Pneumatic Tool Co., each 235 cu. ft. piston displacement; motor driven through Texrope drive.

FEEDWATER HEATER: Cochrane Corp. Rated for 135,000 lb. water from 60 to 245 deg. F. with steam at 20 lb. back pressure; open vertical cylindrical type, with vent condenser.

CIRCULATING PUMPS: DeLaval Steam Turbine Co. Two 3600-g.p.m., 1750-r.p.m. pumps, 39 ft. head, driven by 50-hp. induction motors. One No. 0 Nash Hytor vacuum pump for priming.

TURBINE ROOM CRANE: Box Crane & Hoist Corp. One 20-t. traveling bridge crane, bridge and trolley travel, by hand, electrically operated hoist, two speed, 5 ft. per min. at capacity load, 25 ft. at light load.

SWITCHBOARD: Installed by Ross Electric Co. Equipment generally, General Electric Co. 22 power feeders installed, 18 future. 5 lighting feeders, 3 future. Feeders generally 500,000 circ. mils, but loaded only 400 amp. Oil circuit breakers, 3-pole single-throw, solonoid operated from 125-v. battery. Instruments: Watt-hour meter and amp. meter for each feeder, recording watt meter and watt-hour meter on generator and purchase power connection, graphic voltmeter for purchased power, power factor meters for generators, synchronizer and frequently meter, ground detectors, voltage regulator.

PIPING: Grinnell Co.

HIGH-PRESSURE VALVES: Lunkenheimer Co.

ATMOSPHERIC RELIEF VALVES AND STEAM SEPARATORS: Cochrane Corp.

MAKEUP INSTALLATION: Two Ruggles-Klingemann reducing valves and Schutte & Koerting Co. desuperheater with Swartwout automatic control, capacity, 50,000 lb. per hour.

EXPANSION JOINTS: E. B. Badger & Sons.
STORAGE BATTERY: Electric Storage Battery Co.

PIPE COVERING: Montgomery & Crawford.

INSTRUMENTS: Brown Instrument Co. For each turbine: recording extraction steam gage, two point recording thermometer for inlet and outlet circulating water, same for air before and after generator cooler, recording thermometer for oil temperature, same for extraction steam, recording steam flow meter.
Recording flow meters on each boiler and outgoing low-pressure steam lines, recording pressure gage for steam in main header, recording thermometer for temperature in main header, CO_2 recorder with connections to each boiler. In addition there are Bailey multiple draft gages on boilers, Simplex recording water meters on feed lines, Bristol recording voltmeter, Brown pyrometer.

AIR COMPRESSORS—2: Chicago Pneumatic Tool Co., each 355 c.f.m., motor-driven through Texrope drive.

REFRIGERATING COMPRESSORS—2: I. P. Morris & De La Vergne, Inc.; each 100 t. capacity.

the chief building engineer, Mr. Van den Bosch, acting as technical representatives for the American Enka Corporation. Construction was carried out under the supervision of Lockwood Greene Engineers, Inc., and with close coöperation of the H. K. Ferguson Co., general building contractor.

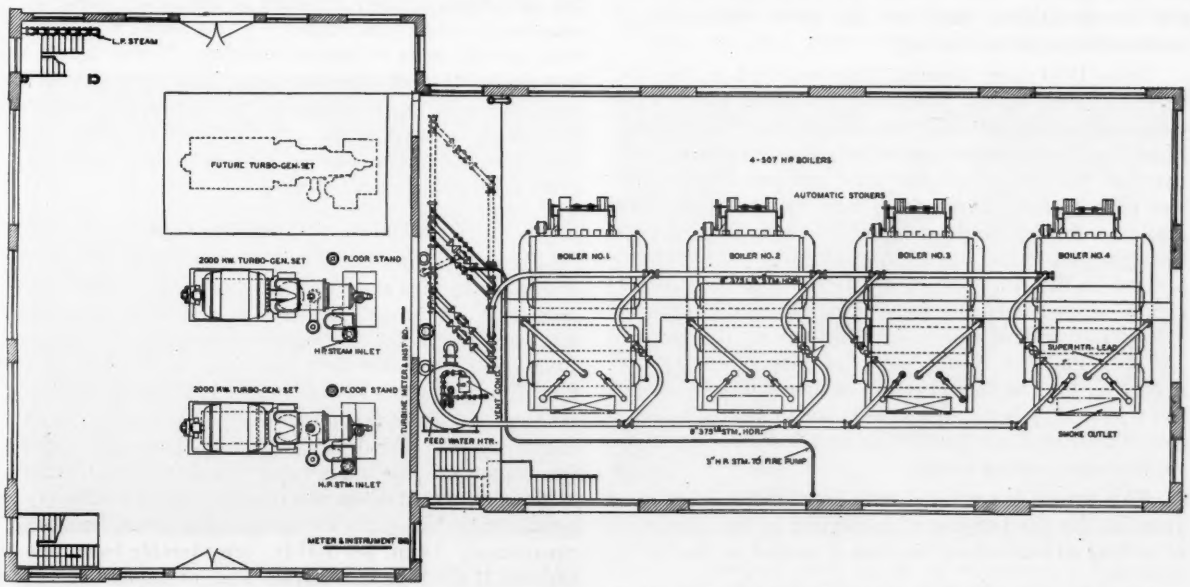


FIG. 6. GENERAL PLAN OF POWER PLANT, SHOWING EXPANSION PROVISIONS ON MAIN STEAM PIPING

Steam Tunnels at the University of Wisconsin

DETAILS OF CONSTRUCTION OF TUNNELS AND CONDUITS, PIPE SUPPORTS, PROVISIONS FOR EXPANSION AND DRAINAGE AND ANALYSIS OF COSTS. BY JOHN J. NOVOTNY*

IN THE CONSTRUCTION of steam tunnels or conduits, considerable study is necessary as to the location, design and future development or load capacity. The proposed location requires the plotting of the area, study of the soil conditions and drainage. It is often necessary to cross principal streets or highways or to go under railroad tracks. All these points have a special bearing on the ultimate costs of the project and some thought must be given to future operation and maintenance costs.

In the development of a growing institution such as the University of Wisconsin, future plans are necessary not only for the grouping of buildings architecturally

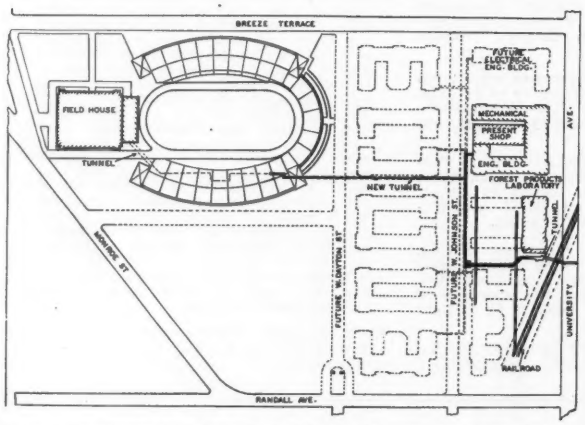


FIG. 1. GENERAL PLAN OF NEW TUNNEL AND CONDUITS TO MECHANICAL ENGINEERING BLDG. AND FIELD HOUSE

and the possible development of the departments but also for the utilities that serve the units, such as steam, water, sewers, power and light.

Since 1900 many changes have occurred in the University. Most of the piping in the older tunnels has been increased in size and new circuits have been added. Since the high-pressure mains have been extended to all parts of the campus, all the pipe supports and accessories have been improved from time to time to conform with the service demands. After much development, therefore, the State Engineering Department has standardized on definite plans of construction in both the design of tunnels and steam conduits which will serve the new Field House, the new Mechanical Engineering Building and the future group of Engineering Buildings, Fig. 1. The tunnel is also designed to take care of the electrical, telegraph, and telephone circuits, bell system, compressed air lines, high and low pressure lines, returns and heating mains.

This tunnel is provided with large manholes at each junction for the purpose of inspection or the possibility of adding additional service lines if needed in the future.

*Chief Operating Engineer, University of Wisconsin, Madison, Wis.

Figure 2 shows the typical detailed cross section of the tunnel.

DETAILS OF TUNNEL CONSTRUCTION

Since the tunnel is laid inside the curb of the proposed street, the top of the tunnel slab is flat reënforced in both directions. In this top slab are laid heavy cast-iron boxrail inserts three feet long, one every 10 ft., from which future service mains may be suspended. The present lighting circuit for the tunnel is neatly bolted to this boxrail as shown.

A few years ago the lighting circuits in one of the tunnels was laid in the roof of the concrete tunnel with outlet boxes flush with the ceiling. It was found that the lighting circuits soon grounded because of accumulation of moisture. Less trouble is experienced in having the lighting circuit below and clear of the tunnel roof. Only in exceptional cases have short circuits developed.

The outstanding improvement of the tunnel is the drainage. On one edge is a 2½-in. by 5-in. trench; on the other edge of the tunnel is a 2-in. by 4-in. trench. Every fifty feet in length is a 2-in. by 4-in. cross trench leading to the 2½-in. by 5-in. trench. In this manner the walkway of the tunnel is always dry even if leaks of any kind should develop in the tunnel. It is necessary to provide a pitch in the tunnel and to be sure that all trenches are free from rubbish.

Figures 1 and 3 show a typical view of the design for the section of the tunnel constructed under the railroad tracks. Note the special slots or grooves, cast in the side wall of the tunnel, in which electric cables and telephone service wires are laid. Collapsible wooden forms were used for forming the interior of the tunnel. The forms for slots were securely fastened to the forms, using well seasoned Norway pine lumber. These forms were coated with several coats of heated paraffin. It was found by experiment that, if these forms for slots were pitched on one side ½ in. in 3 in., the forms were easily removed and could be used repeatedly for 1000 ft. before they were renewed. The photographs show how neatly the grooves are cast in the concrete.

PIPE BRACKETS AND PIPE CHAIRS

Figure 7 shows the detail of pipe brackets and the design of the pipe chairs. These brackets are built up of angle-iron, reënforced vertically with steel plate and riveted. A wide bearing surface is riveted with countersunk rivets. The brackets are bolted to the face of the 8-in. I-beams, which are embedded in the side wall.

Figure 6 shows the detail of expansion joints and anchor supports. The design of pipe anchors and supports for expansion joints provides flexibility in alinement. When once bolted down and dowelled, their positions are permanent. Since the expansion of a steam line is approximately 3.4-in. per 100 ft., considerable bare pipe is exposed if the pipe must either slide or expand on roller bearings.

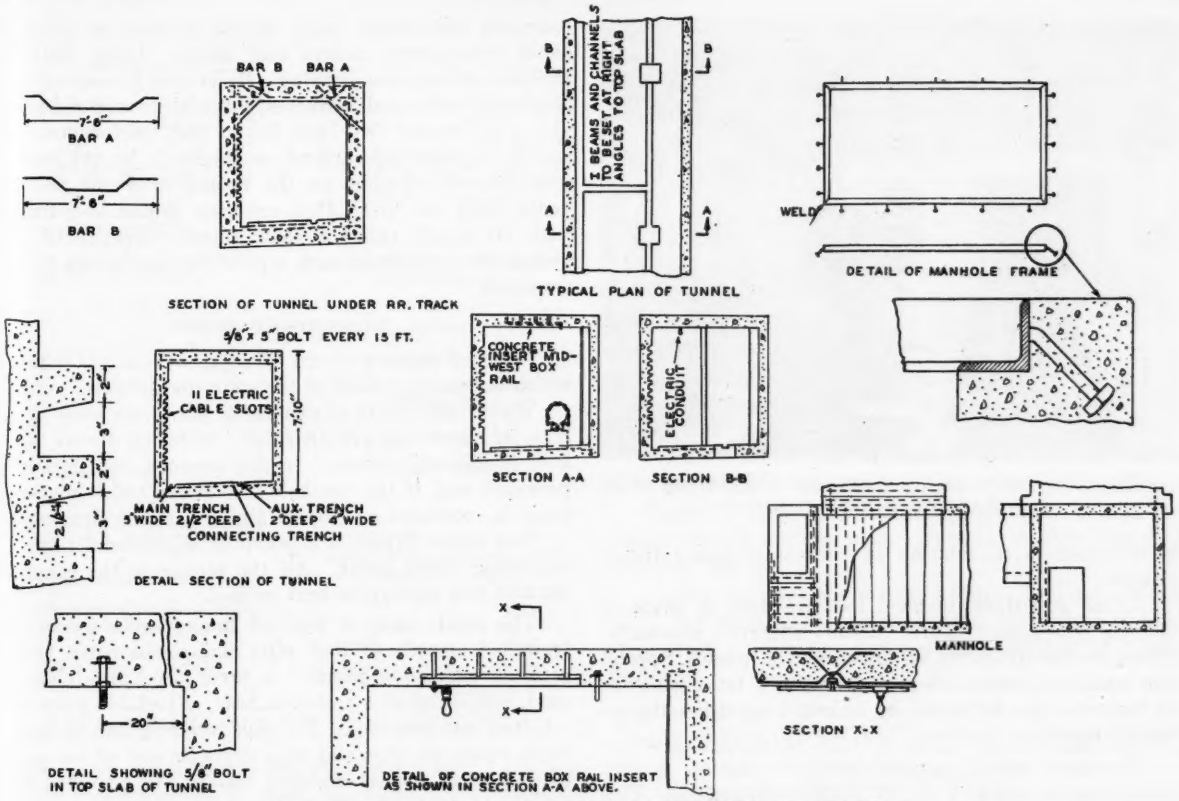


FIG. 2. TYPICAL CROSS-SECTIONS AND DETAILS OF TUNNEL

To overcome this objection and the loss of heat due to bare pipe and broken joints in the covering, the University has adopted a pipe chair as shown on Fig. 7. It is recessed and neatly fitted around the pipe and securely clamped to the pipe with a U bolt. In this manner the pipe covering can be neatly fitted around the pipe chair and U-bolts, thus reducing heat loss. Since the brackets are bolted to I-beams on the side walls, these brackets are slightly tilted before being bolted in place. This allows the base of the pipe chairs to bear evenly on the face of the brackets and aids in the alinement of the pipe line.

Figure 9 shows a typical manhole junction and the takeoff to future buildings.

Drainage of Tunnnel

Drainage trenches of the tunnel lead to a large concrete sump. Vertical, automatic, motor-driven pumps remove seepage that collects from time to time. For further protection, automatic water syphons are provided in case the electric current fails. At this same junction, the condensation of the pipe lines is removed by high-grade steam traps. These traps discharge into vertical, cast-iron receiver from which the condensation

FIG. 3. VIEW OF TUNNEL UNDER RAILROAD TRACK SHOWING SLOTS FOR CABLES, PIPE SUPPORTS AND DRAINAGE TRENCH

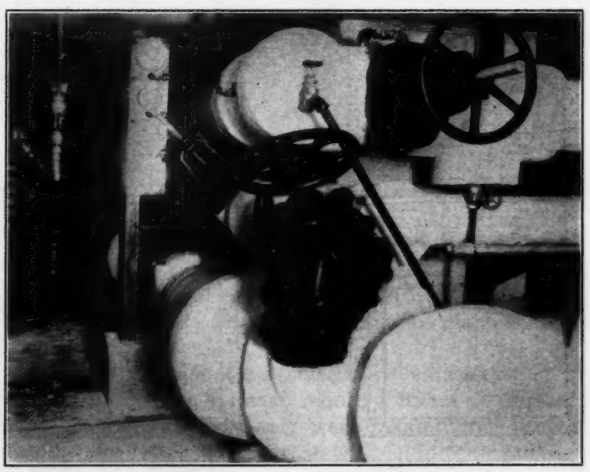


FIG. 4. VIEW OF PIPE LINES AT MANHOLE C, LOOKING WEST, SHOWING FUTURE OUTLETS AND ANCHOR SUPPORTS

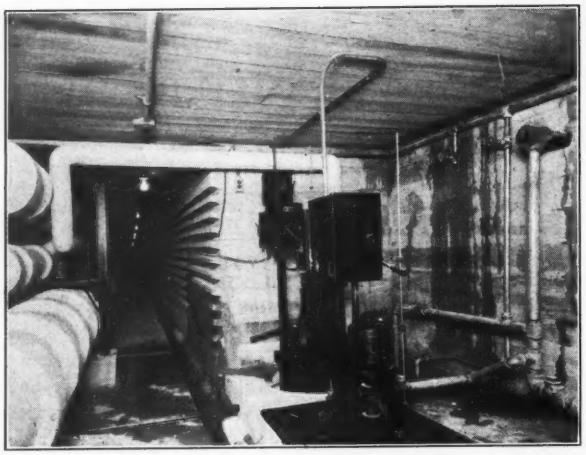


FIG. 5. ANOTHER PART OF MANHOLE C, SHOWING SUMP AND CONDENSATION PUMPS

is returned to the station by automatic motor-driven pumps.

At all junctions, blanked tees are used in place of elbows, providing future outlets wherever necessary. These are clearly shown on drawings and photos. Special size manhole frames are provided with a locking device so that they can be locked or unlocked on either the inside or outside.

As stated before, tunnels should be planned to give continuous service at a minimum maintenance cost. This can be attained by using quality materials, arrangement of piping so that there is flexibility of pipe circuits and accessibility of equipment. The main protection of the pipe lines is the pipe supports and alinement and the installation of sufficient steam traps properly located to remove the condensation from the mains. Ventilation of the tunnels is essential for repair work or changes. Operation costs can be reduced to the minimum by properly applied pipe covering, periodic inspection, prompt repair, adequate lighting, and proper drainage of the tunnel itself.

Log sheets and maintenance records should be encouraged and repair parts should be kept on hand to avoid unnecessary delays and losses. Long distance pressure records are of value. Recording pressure gages should be used on all branches, especially when reducing valves are used. We have found that performance of steam traps can be checked continuously by the use of temperature recorders on the return lines and telltale vents along the line. Pipe covering should be painted with oil paint, using a color scheme throughout the system that will make each type of service known to the employes.

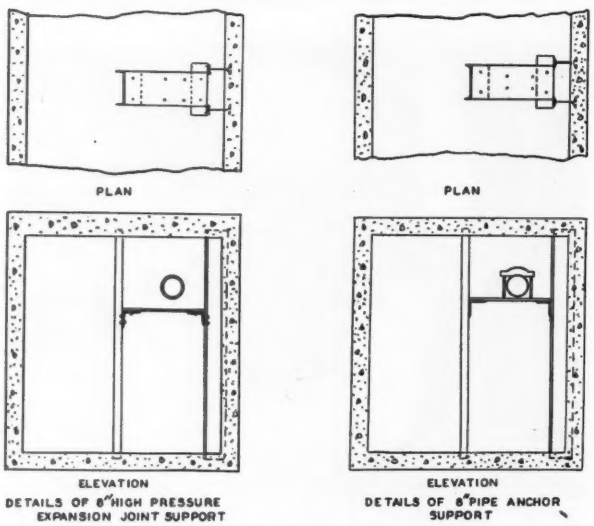


FIG. 6. DETAILS OF EXPANSION JOINTS AND PIPE ANCHOR SUPPORTS

Concrete Conduits

Figure 8 shows a design of a typical concrete conduit which is generally used in the state institutions.

Where slip joints or expansion joints are used, manholes of ample size are provided. Note the double manhole frames and covers. In this manner, ventilation is provided and, if the manhole is shallow, ample working room is provided to inspect and repair the equipment.

Van Stone flanges are provided wherever fittings or expansion joints occur. All the piping in the concrete conduit was aceteylene butt welded.

The inside base or floor of the concrete conduit is trowelled smooth so that pipe chairs can move freely between expansion joints. A three-piece pipe chair is used, consisting of a cast-iron base, adjustable yoke and a bolted cast-iron cap. The pipe covering can be easily fitted about the pipe and pipe supports and at the point of anchorage special cast-iron clamps are provided and securely bolted into place. Long-sweep bends are used wherever possible to avoid expansion joints. The steam, return and compressed air lines leading to the new Field House are laid in concrete conduit as shown in Fig. 8.

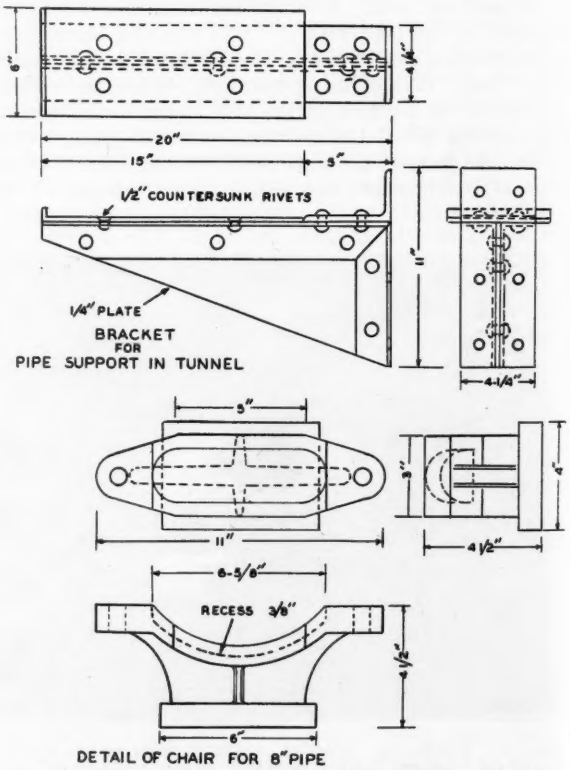


FIG. 7. DETAIL OF PIPE BRACKET AND CHAIRS

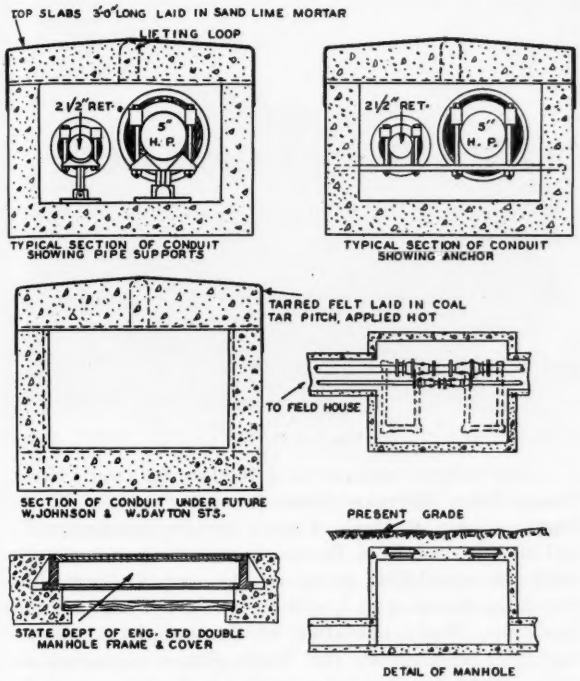

TOP SLABS 3'-0" LONG LAID IN SAND LIME MORTAR
LIFTING LOOP
2½" RET.
5" H. P.
TYPICAL SECTION OF CONDUIT SHOWING PIPE SUPPORTS
2½" RET.
5" H. P.
TYPICAL SECTION OF CONDUIT SHOWING ANCHOR
TARRED FELT LAID IN COAL TAR PITCH, APPLIED HOT
TO FIELD HOUSE
SECTION OF CONDUIT UNDER FUTURE W. JOHNSON & W. DAYTON STS.
PRESENT GRADE
STATE DEPT OF ENG. STD DOUBLE MANHOLE FRAME & COVER
DETAIL OF MANHOLE

FIG. 8. DETAILS OF FIELD HOUSE CONDUIT

Thence the steam line is run overhead, under a portion of the football stadium, supplying steam to the football training quarters, then down again into a 100-ft. conduit to the service room of the Field House.

Steam supplied to the Field House will be metered, using indicating, integrating and recording flow meters. Steam lines at the training quarters are equipped with condensation meters for the heating and hot water service. Long-distance pressure recorders will record the pressure at the central heating station, 3300 ft. away. Various temperature and pressure recorders will be used at the Field House.

Plans and specifications were prepared by the State Engineering Department. John C. White is the designer of the concrete conduit which was adopted by the State Engineering Department.

Cost of Tunnels and Conduits

Approximate cost of the concrete work of the conduit was $3.36 per ft. Approximate cost of the 2½-in. return, 5-in. extra heavy pipe, expansion joints, covering, anchors and supports was $7.85 per ft. Total cost of the conduit was $11.21 per ft.

Approximate cost of the excavation, forming and the concrete for the tunnel was $14.01 per ft. The approximate cost of 14⅜-in. O. D. wrought iron pipe, 8-in. extra heavy steel pipe, 5-in. standard wrought iron pipe, valves, fittings, supports, pumps, air lines and lighting complete was $29.80 per ft. The total cost was $43.81 per ft.

Figure 4 is the view looking west showing the alinement of pipe on the brackets, concrete bases for the low pressure main and also grooves for the electric cable and drainage trenches. All iron work was painted with special non-rusting paint. The I-beams were marked with white lead to aline the brackets and then repainted black.

Figure 5 shows part of manhole C shown on Fig. 1. Note the sump and condensation electric pumps in place.

Figure 4 shows the balance of manhole C and the tunnel section looking west. Note the anchor supports and gage board.

Figure 3 shows the design of slots for the electric cable, supports, pipe supports, and the design of concrete work under the railroad track siding at Camp Randall.

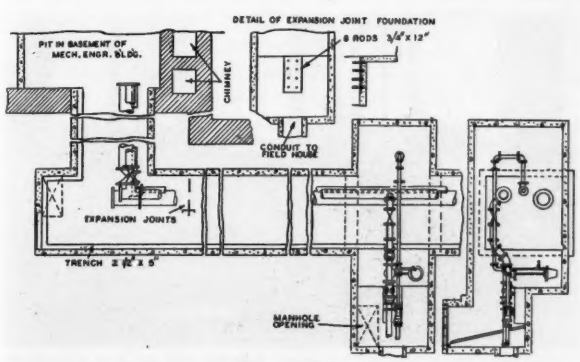
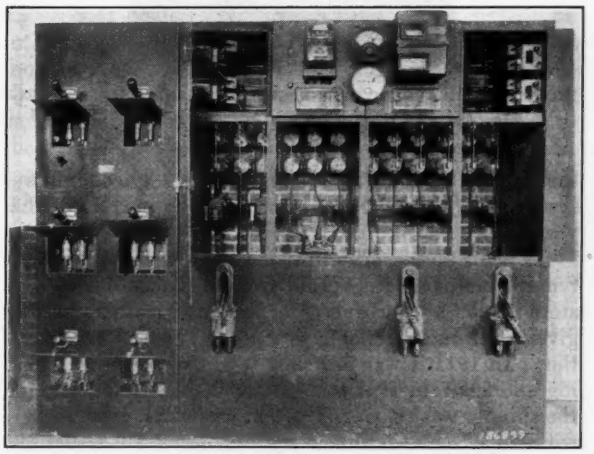


FIG. 9. DETAIL OF TAKEOFF TO FIELD HOUSE AND CONNECTION TO MECHANICAL ENGINEERING BUILDING

Switchboard and Controller Installed in Six Hours

Confronted with the problem of installing a switchboard in a few hours, the Central Illinois Public Service Co. purchased a steel clad switchboard, built and assembled in the shops of the Westinghouse Electric and Manufacturing Co. for installation in the ice plant at Cairo, Ill.



STEEL CLAD SWITCHBOARD INSTALLED IN CAIRO, ILL., ICE PLANT IN SIX HOURS

This equipment was designed in such a way that the number of hours of labor required to install it was a minimum. Six hours only were required for its complete installation, whereas, if this equipment had been assembled in the ice plant, about four days would have been consumed in its installation using the same number of men.

Veterans of the Power Plant Complete

Twenty-Seven Years Service Together

FIRST COMMERCIAL WESTINGHOUSE TURBO-GENERATOR, NO. 24, INSTALLED IN 1903, STILL IN SERVICE AT MASSEY-HARRIS CO., BATAVIA, N. Y.

BACK IN 1903, turbines were not as numerous nor as popular as they are today and it no doubt took considerable courage on the part of the Massey-Harris Co. (then the Johnston Harvester Co.), Batavia, N. Y., to install one in the new power plant built that year.

With commendable foresight, however, the turbine was installed and the company now has the unique honor of having the first commercial Westinghouse steam turbine to be built, No. 24. This is probably the oldest

FIG. 1. WM. WESCOTT PROBABLY HAS THE LONGEST RECORD OF ANY ENGINEER IN THE COUNTRY AS A TURBINE OPERATOR

turbine in this country still in regular service as it was installed in 1903 and first operated in September of that year.

It is, in fact, a grandfather among turbines, and the remarkable part of it is that with the exception of some store teeth, a prerogative of all grandfathers, it has given continuous reliable service ever since its installation. In 1911 it was returned to Pittsburgh for rebladding and again in 1921 some of the blades came loose and the spindle was taken to Buffalo where the grooves were recut to accommodate new style blades.

Of course this machine has not carried the full load of the plant for 27 years. Massey-Harris Co. manufactures modern farm equipment and in time the power load exceeded the 400-kw. capacity of the "old" machine and the "new" unit rated at 600 kw. was purchased. The "new" turbine is Westinghouse No. 893, installed in 1911.

The "old" turbine has 68 double rows of blades, 34 in the high pressure section, 18 in the intermediate section and 16 in the low pressure section. It has the following data on the turbine nameplate:

Westinghouse Machine Co., Designers and Builders
Pittsburgh

Westinghouse, Church, Kerr & Co., Engineers
New York

No. 24 Kw. 400 R.p.m. 3600

and on the generator nameplate:

400 Kw. 440 E.m.f. Amps. per turn 455
2 Phase 7200 Alts. Speed 3600
Serial 192,566

This turbine exhausts to a 1000-sq. ft. Deane Steam Pump Wks., Holyoke, Mass. (now part of the Worthington Pump & Mach. Corp.) surface condenser No. 38139W, served by a Deane direct acting steam pump with the circulating pump on one end, a wet vacuum pump on the other end, and the steam cylinder between the two. Early operation of the complete unit was carefully watched by the Westinghouse engineers and some slight changes were made during the first few months. The turbine was then in steady operation until 1911, at times carrying loads considerably in excess of its rating. In January, 1911, the "new" turbine was put in operation. After this larger machine had taken over the load, the old turbine was returned to Pittsburgh where it was rebladed. Previous to the overhauling given the machine at that time, the only major repair had been the rewinding of the generator field. This had been burned out on account of heavy overloads.

Since 1911, the principal portion of the load has been carried by the 600-kw. machine, although, at times of heavy load, both machines have been run together and during practically every year there have been periods when the old machine has carried the entire load. In July, 1921, 13 rows of blades in the high-pressure cylinder of the old turbine loosened. These were of the old style, straight type blade. In repairing the damage done to the blading at this time, the spindle was sent to Buffalo where the grooves were recut to accommodate the new style hook type blades and these new blades were put in the entire low-pressure cylinder as well as in the 13 rows of the high-pressure cylinder. Since 1921,

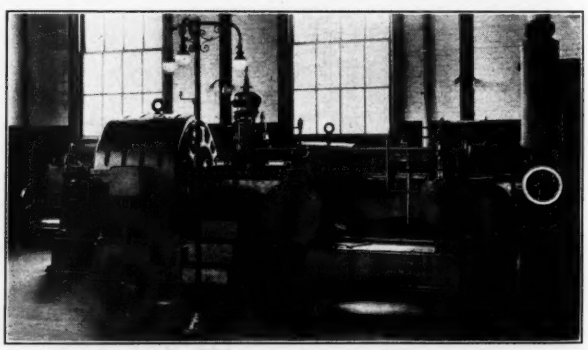


FIG. 2. NO. 24, THE GRANDPA OF ALL WESTINGHOUSE COMMERCIAL TURBINES, IS STILL IN ACTUAL OPERATION

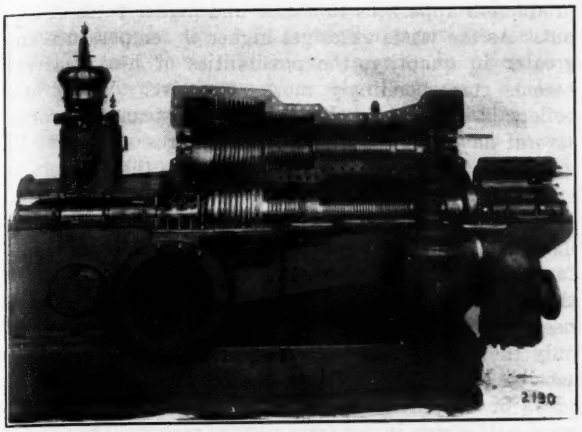


FIG. 3. WITH THE UPPER HALF OF THE CASING RAISED TO SHOW THE CONSTRUCTION

no further repairs have been made to this machine and it has been ready at all times to carry the load up to its capacity.

In the spring of 1926, one of the sealing glands of the spindle of the 600-kw. turbine split lengthwise and forced emergency repairs. The cover of the turbine was removed and the split gland was closed up and held in place by means of a winding of armature binding wire drawn up and soldered as would be done on motor armature. This temporary repair kept the machine in service until September, 1926, at which time the annual inspection, cleaning and repair work was done. At that time, new sealing glands and runners were placed on the shaft.

As an indication of the care with which the lubricating systems on both of these turbines were worked out and of the attention that has been given to their operation, it may be pointed out that in both machines the original bearings and thrust blocks are still in use. The original spindles are still in service and with the exception of the generator field windings on the 400-kw. machine, the original windings are intact.

Another piece of equipment still in everyday operation is the Laidlaw-Dunn-Gordon (now another unit of the Worthington Pump and Mach. Corp.) 11 and 18 by 18 and 11 by 12 in. two stage cross compound steam driven air compressor with a Meyer valve gear. This compressor was installed shortly before the turbine and although subsequent air compressor capacity has been installed, the fact that the old machine is still in regular everyday service speaks volumes for the workmanship and material of which it is built and the attention and care which it has received.

In 1903, turbine engineers were scarce and it was necessary for the Massey-Harris Co. to go to Ithaca, N. Y., for Wm. M. Wescott, Chief Engineer of the Ithaca Street Railway Co. plant. For seven years previous to 1900, Mr. Wescott had been engineer of the Sibley College, Cornell University, power plant at which they had a 200-hp. turbine used for experimental work. Coupled with his record at Batavia, this gives Mr. Wescott a continuous record of over a third of a century of turbine operating experience, a record which probably is not equalled by any other engineer in this country and probably not in the world.

Such a record of service, both of man and machine, is unusual and we appreciate the courtesy of the Massey-Harris Co., particularly F. J. Wilson, Supt. of the Malleable department, in looking up the records and facts for us to present to the engineering public.

Improving Industrial Heat Cycles

W. F. RYAN INDICATES POSSIBILITIES OF WASTE HEAT USE BEFORE WORLD POWER CONFERENCE

WHERE THE COST of oil fuel and other conditions have made its use economical, the Diesel engine has been used for many years as a prime mover in industrial plants. Industries which require process steam have generally found it cheaper to use steam-driven prime movers but, even in this case, oil and gas engines have been effectively used in conjunction with steam boilers. Boiler feedwater has been used as a cooling medium in the cylinder jackets and in some cases the heat in the exhaust gas has also been utilized for preheating feedwater.

Recently a number of Diesel engines have been installed to perfect the heat balance of industrial plants. Attention has been called to the lack of synchronism between steam and power demand in the average industrial plant, so in the past it has been common practice to design the electric power plant to meet average conditions and to blow exhaust steam to the atmosphere whenever the demand for power was out of proportion to the demand for exhaust steam. Condensing units, to take care of this condition, are impracticable in plants which lack an abundant supply of cold water. A purchased power connection is also frequently undesirable, on account of the high cost of furnishing current for intermittent use while the hazards of interconnection sometimes makes it difficult to secure an exact balance by this method. In this situation, the Diesel engine generator becomes a very effective method of perfecting the balance. All the power that can be generated noncondensing, and without waste of exhaust steam, is obtained from steam prime movers; the deficiency is supplied by the Diesel. The heat saving is obvious; a noncondensing steam engine may reject 20,000 to 40,000 B.t.u. for every kw-hr. generated, whereas the heat loss from a Diesel need not exceed 4500 B.t.u. per kw-hr., even if no attempt is made to recover heat from jacket water or exhaust.

Internal combustion engines are also commonly used for starting up service in isolated plants. Where all auxiliaries are motor driven, as is now common practice, and where electric current is required for fuel supply, which is usually the case in pulverized coal plants, the boiler can not be put into operation after a complete shutdown without some auxiliary source of power. A small gasoline engine driven generator is usually sufficient for this purpose.

Again there are industrial plants in the United States which use as much as 100,000,000 gal. of cooling water a day. In some cases, this water is heated as much as 40 deg. F. and represents a potential energy source, at Carnot efficiency, of more than 30,000 kw. continuously. It would be costly, but entirely feasible from an engineering point of view, to install apparatus which

would extract more than 10,000 kw. continuously from this warm water, without any expenditure for fuel.

Other plants discharge smaller quantities of water at much higher temperatures. Some chemical plants in Europe are actually extracting electric power from how waste liquors. Vapor, flashed from the hot liquor, is drawn through a turbine into a condenser. The operating pressure may be as low as 5 lb. absolute. Except in exceptional cases, the development of power from this source is not yet commercially practicable in the United States, but it would appear to offer a much more economical source of power than exists in the differential temperature between the surface and the depths of the sea. The work of Claude and Boucherot on the latter project is of exceptional interest, and the author does not wish to disparage their experiments in any way. The ultimate value of this research, however, may be found in the recovery of energy from the higher heat head of industrial wastes.

We may also look for a renaissance of the waste heat boiler in the industrial plant as we are pushing all production apparatus to higher and higher rates of output. As the waste gases get higher in temperature and greater in quantity, the possibilities of heat recovery become correspondingly more attractive. Waste heat boilers have been developed for high steam pressures; several have been installed for pressures above 350 lb. ga. (23.8 at.), and this further increases the recoverable energy.*

Hot gases are also being used directly, or through the medium of an air heater, for drying and for other manufacturing requirements. At the Iron Mountain plant of the Ford Motor Co., stack gas from the power plant is used for drying wood. This plant, which utilizes not only the latent heat of the exhaust steam but also the sensible heat of the stack gases, eliminates the two major losses in the central station. This is the goal for which we should strive in low temperature ranges. If operated at the highest economical steam pressure, distributing cheap surplus power to less fortunately situated neighbors, such a plant would represent the ideal industrial heat power cycle.

Instrument Arrangement in Modern Plants

CENTRAL GROUPINGS, PARTIAL GROUPING AND UNIT GROUPING OF INSTRUMENTS. USE OF AUTOMATIC ALARMS IS INCREASING, ACCORDING TO THE N.E.L.A.

INSTRUMENTS ARE APPLIED and used in modern power plants for three principal purposes, namely: operating guidance through which the proper plant conditions are maintained and operation is made safe and continuous; operating supervision and economical operation; calculation of machine, department and plant performance over a period of time such as a shift, a day, a week or a month.

Advantages to be derived from the use of instruments in power plants arise not only from the data of particular measurements but also from the correlation of the indications of one instrument with that of another. This has naturally led to the grouping of instruments to the best advantage and intertwining the selection and location of instruments with that of machinery control.

At the one extreme, the instruments for any piece of apparatus may be located singly at the nearest point of application which may or may not be adjacent to or within view of the apparatus control point. The operator is therefore required to make a circuit among the several instruments in order to obtain readings. At the other extreme is the centralization of all instruments within a small radius whereby one operator has within his observation continuously all the pertinent features of plant operation. Between these two there are, of course, many modifications.

COÖRDINATION OF ALL UNITS GIVES BEST RESULTS

Fundamentally, the object of centralized control in the grouping of instruments is for facilitating operating supervision. It is usually adopted with the idea that the best plant operation is to be secured by the coördination of all units in the plant, whether they be boilers, turbines or auxiliaries and that this coördination can best be maintained by delegating complete authority and responsibility to a single operation. Reduction of operating labor is usually of secondary consideration although centralized control tends to reduce labor to a minimum.

Centralized control can be accomplished only with the aid of instruments which will reveal to the central operator all pertinent information necessary for the control of the plant. Often these centralized instruments are duplicated at the individual piece of equipment in order to allow observation there in case of trouble with the normal system of control and for starting and stopping of the apparatus. Logical division seems to be the use of indicating instruments at the individual apparatus with corresponding recording instruments at the central instrument board.

PARTIAL CENTRALIZATION OFTEN FAVORED

This trend toward centralization started several years ago with the centralization of boiler controls. The addition of turbo-generator and electric switching control is a newer undertaking and, as a rule, is used only where plant design and electric distribution requirements are favorable. Partial centralized grouping of instruments is a compromise between the old unit grouping system and the centralized grouping and falls naturally into three groups, as follows:

First, a central gage board in the turbine room where such data as steam pressure and temperature, auxiliary power supply information, feedwater temperature, station air pressure, service water pressure, storage tank levels and other data applying to the entire station are indicated or recorded. Various annunciators are also located on this board, which is usually located where the shift superintendent or watch engineer makes his headquarters.

Second, flowmeter panels containing a group of

meters measuring condensate, steam, make-up, city water supply, boiler feed, auxiliary turbine steam and condensate, flows. These meters may be placed at the central general instrument board or may be located wherever convenient in isolated spots. The meters are used to obtain data for calculation of plant or equipment performance and are not regularly referred to by the operators for guidance and so have no relation to apparatus control.

Third, heat balance panels on which are grouped instruments necessary for operating guidance and supervision. Flowmeters, recording thermometers, indicators of auxiliary generators and indicators of auxiliary drives compose most of the instruments on these panels. The evolution of this type of central instrument board was probably at its peak when more than one turbine delivered condensate into a common feedwater heating system and before closed heaters and motor drive of auxiliaries became so general.

Automatic Alarms Protect Equipment

Unit grouping of instruments, that is the custom of locating one or more instruments near the operating controls of individual pieces of apparatus, is of long standing. The introduction of multiple feedwater heaters, steam reheating, closed type generator cooling and unit operation of turbine and auxiliaries has greatly increased the number of instruments associated with any turbo-generator. The practice of reading temperatures from isolated thermometers becomes too bothersome and in consequence labor saving instruments are used. As to the turbine control panel, there may be added a number of instruments to show bleeder steam conditions and feedwater temperatures through the heaters, the instruments used in each case depending upon the particular requirements of the plant.

There appears to be an increasing trend in the use of alarms of the light, bell, whistle and annunciator types in the safeguarding of apparatus.

Relatively minor cost of instruments of this type compared with cost of damage to the equipment guarded is almost negligible. Probably the most common alarm is applied to the generator air cooling system for which alarms actuated by coil temperature, cooling air temperature and cooling water temperature may be used. Transformer temperature, bearing oil pressure, intake tunnel water level, water storage tank level, hotwell level, emergency make-up water, pressure condenser leakage and auxiliary power supply voltage are other alarms widely used. High and low water level in boiler drums, preheated air and reheat steam temperature are also subject to automatic alarms, while the introduction of pulverized coal firing has shown the need of bin level primary air pressure and various interlock alarms. Even excess coal temperature alarms are in use in some stations and annunciator panels have also been adopted for showing the tripping out of auxiliary drive motors.

Instrument selection should closely follow or be coincident with design studies of the plant and when the new plant is an addition to an existing plant or group of plants, the prevailing method of operating analysis and comparison of results should be carefully considered and the instruments selected to meet these conditions.

New Boiler Plant for Slatersville Finishing Co.

SLATERSVILLE FINISHING CO., a division of The Kendall Co. at Slatersville, R. I., has put into operation recently its new boiler plant. Having 1200 hp. in two units, with provision for a third unit, the plant furnishes process steam for the many requirements of a textile finishing plant and the equipment is such as to be adaptable to steam power generation when that becomes advisable.

Present consumption of steam for processing is at the rate of 150,000,000 lb. a year. Peaks of 55,000 lb. per hr. are at present carried on one boiler, leaving the second boiler as a spare. Each boiler is capable of carrying peaks of 70,000 lb. per hr. Temple and Crane, Inc. of Boston constructed the building.

The coal bunker is the overhead suspension type, with capacity of 200 t. Coal delivered to the plant by truck is dumped into a receiving hopper which delivers to the coal crusher. Thence it passes to a bucket elevator and on to a screw conveyor which discharges it into the overhead bunker. From the bunker the coal is passed through a Richardson automatic coal scale.

Two cross-drum Babcock and Wilcox boilers, equipped with superheaters and soot blowers, operate at 150 lb. gage, with 50 deg. F. superheat but are designed to operate at 250 lb. gage with 150 deg. F. superheat, when steam power generation becomes a part of the plant's service. The boilers are fired by five-retort Taylor stokers having a projected grate area of 123.7 sq. ft. each, capable of driving the boilers at 300 per cent rating. Stokers are driven by either a Lewis Allis four-speed motor or by a Moore steam turbine. Furnaces are 9 ft. by 14 ft., with Bernitz air-cooled walls at front and sides and a Foster-Wheeler water-cooled rear wall. Allen-Sherman-Hoff ash hoppers with quenchers and water-sealed sliding gates are installed under each boiler.

Ash is dumped direct into an ash car on tracks below the ash hoppers. Coal handling equipment, ash car and tracks were furnished by the Stephens-Adamson Manufacturing Co. Air ducts convey air to the furnaces from a Buffalo Forge Co.'s turbo-conoidal fan having a capacity of 42,870 cu. ft. per min. under a pressure of 5.5 in. of water.

Products of combustion are carried off through boiler uptakes and smoke flue to a Custodis radial brick chimney. Air ducts, boiler uptakes and smoke flue were furnished by the Connery Co.

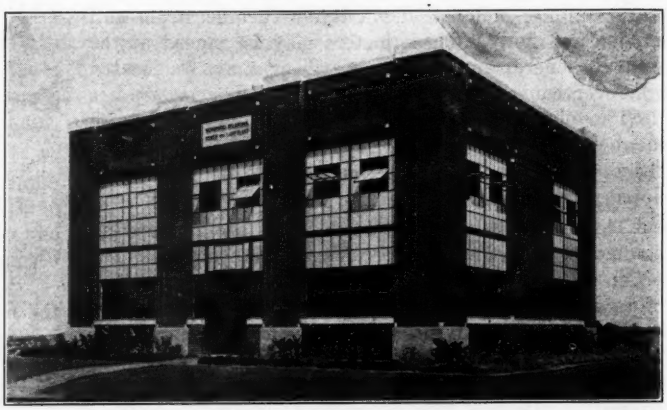
Two Warren Steam Pump Co.'s single-stage centrifugal pumps supply all water for the plant. Returns from the mill pass directly into a 120,000-lb.-per-hr. Cochrane deaerating feedwater heater. Make-up water is taken from the service main or by means of a bypass may be delivered to the feed pumps directly. There are two feed pumps, one a 10 by 6 by 12-in. duplex pump taken from the old boiler plant, the other a 3-in. Warren Steam Pump Co. three-stage centrifugal boiler feed pump direct connected to a Whiton steam turbine. Each boiler is equipped with Bailey meter, multiple pointer draft gage and Hagan flue damper control based on furnace pressure. Forced draft is controlled by R-K regulator.

Chas. T. Main, Inc., of Boston, was engineer.

Low Diesel Operating Costs

Seven years operation with Diesel power at Woodward, Oklahoma, demonstrates economy of investment.

By Harry J. Achee*



WOODWARD, OKLA., converted its municipal plant in 1922 from an old dilapidated steam plant consisting of two 125-kw. steam engine units of different makes and one 150-kw. steam turbine unit, into a Diesel engine plant. The new plant as installed consists of two 520-hp., 4-cylinder, 4-cycle, McIntosh & Seymour Diesel engines.

Operating Costs With Old Steam Plant

For the last 365 days of operation of the steam plant, the average delivered cost of the coal used each day was $119.05. The corresponding cost of fuel oil amounted to $8.56 per day. Packing and waste costs came to $1.58 per day while the actual amount paid for repairs alone, including shop work, welding of flues and grate replacements for the boilers but not including any new pieces of equipment was over $40.00 per day. Nineteen men were employed at the plant regularly and 21 additional men on special occasions.

High cost of coal was due largely to the geographical location of the plant with respect to the mines, which made the freight charge always higher than the coal itself. Another influence was the coal miners' strike, which was on at the time, causing a constant increase in the price of coal.

Since the building of the new plant to which the old pumping equipment was moved and placed in a pit at which a new switchboard, necessary water cooling system and fuel oil tanks were installed, more current has been produced than ever before as will be seen by inspecting the accompanying charts. Lubricating oil cost is less than $1.50 a day and the fuel oil cost has averaged below $15.00 per day. Repair and replacement costs were negligible. Six men, only, are now employed to operate the plant, including a chief engineer, two operating engineers and three oilers.

In July, 1927, an 840-hp., 2-cycle, solid-injection, 6-cylinder, Fairbanks-Morse Diesel engine was added. This engine was paid for by a pledge plan out of the monthly earnings of the light and water earnings at the rate of $18,000 per yr. The cost of rebuilding the cooling system and foundation and the cost of the building extension were paid out of the earnings of the year of installation. At no time has there been any general tax levy by the city; profits of the water and light department paying for all city administrative expenses.

*Supt. Hobart Light & Water Co., formerly Supt. Woodward Water & Light Plant.

FIG. 1. INITIAL INSTALLATION OF TWO 520-HP. McINTOSH AND SEYMOUR DIESEL ENGINES TO WHICH AN 840-HP. FAIRBANKS-MORSE DIESEL ENGINE WAS ADDED LATER

Power Costs and Earnings

Total costs and earnings for the last five consecutive years are tabulated as follows:

	1925	1926	1927	1928	1929
Total collections for light and water.....	$70,964	$82,558	$96,903	$106,026	$115,065
Credits for street lighting, water pumping..	10,750	11,000	11,650	12,250	12,500
Total cost of operation, ext., maint., and imp.	44,623	46,404	84,590	66,135	57,125
Apparent profits of light and water dept.....	$37,091	$47,154	$23,963	$ 52,141	$ 70,440

Cost Summary

Gross apparent profits of light and water for 5 yr.....	$230,789
Average profits per year for the 5-yr. period.....	46,137
Actual profits for the 5-yr. period.....	172,639
Actual credits for water pumping and light service.....	58,150
Total amount collected, 5-yr. period, water and light...	471,516
Total improvements and extensions, w. and l., 1927.....	43,000
Amount transferred to sinking fund from w. and l., 1927	17,000

Improvements and extensions made during the year 1927 amounted to the following costs which will account for the low profits recorded for that year. These costs included overhauling of engines which is an expense accumulated over a period years since no apportioned fund, which would properly distribute such costs, had been established for this purpose.

Overhauling two McIntosh Diesel Engines.....	$ 8,000
Foundation and temporary building for new Diesel eng.	3,000
Water lines, extensions and improvements.....	12,600
Light lines, extensions and improvements.....	12,300
Seven blocks white way installed on separate circuit...	5,200
Total extension costs for 1927.....	$ 41,100

The average kilowatt-hours generated per gallon of fuel oil for the 5-yr. period was 9.28. This includes fuel oil burned in the three heaters used for heating the power plant, since no provision had been made to meter this supply independently of the supply for the engines.

For the year 1928, the average gallons of water pumped per day was 565,000 and the corresponding average cost to deliver water into the mains per 1000 gal. was 3 cents. For the entire year, electricity was cut off only three times, totalling 25 min.

Woodward Electric Rates Are Low

Electric rates were voluntarily reduced 20 per cent in 1928 to the present rates which range, for domestic lighting, from 10 cents per kw-hr. for the first 25 kw-hr. to 4 cents for all over 100 kw-hr. Corresponding charges for business service are 10 cents for the first 50 kw-hr. to 4 cents for all over 200 kw-hr. General power rates run from 10 cents for the first 25 kw-hr. down to 3 cents for all over 100 kw-hr. Industrial power rates are still lower, ranging from 3 cents for the first 100 hr. of connected load to 1½ cents for all over 500 hr. of connected load. Water rates range from $1 as minimum charge for the first 3000 gal. and 20 cents per 1000 gal. for the next 5000 gal. to 7 cents per 1000 gal. in excess of 500,000 gal.

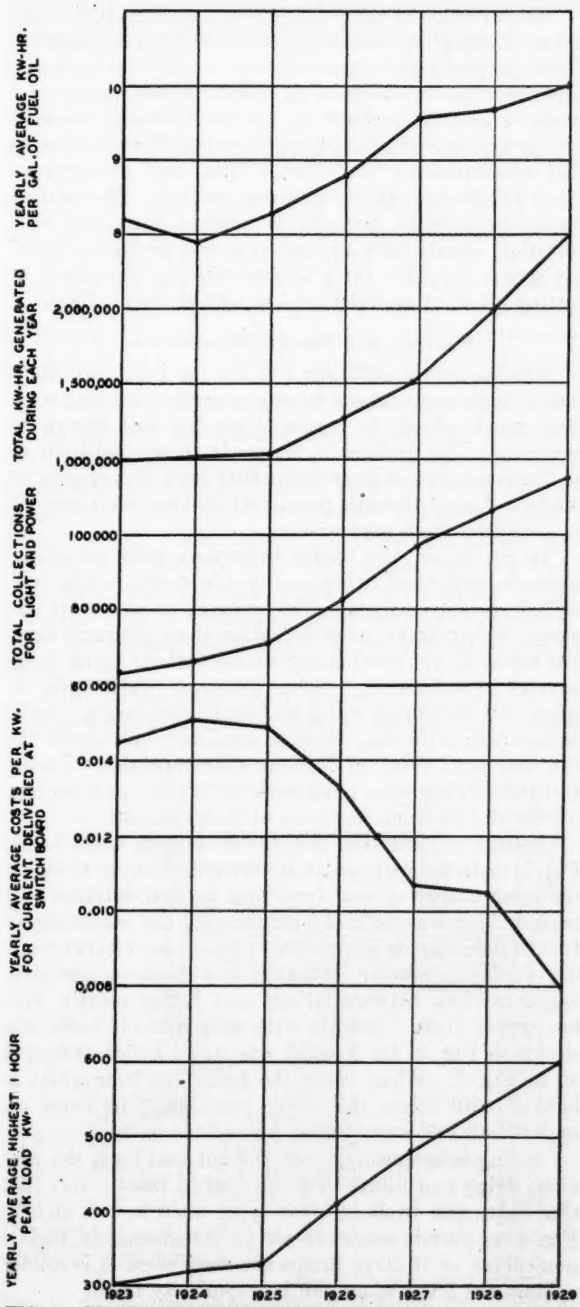


FIG. 2. CHART SHOWING VARYING COST AND OPERATING DATA FOR A 7-YR. PERIOD

Inspect Hand Tools

Improper use of hand tools, neglecting to keep them in proper condition and leaving them in dangerous places, are frequent causes of accidents, according to the National Safety Council. It is important that the proper grade of material be provided for the various kinds of hand tools required, depending upon the purpose for which the tool is to be used. For instance, chisels, punches and drifts made from poor stock soon become dull and their heads upset, mushroomed and cracked, thereby rendering their use hazardous. The penetrating power of a piece of flying steel from the mushroomed head of a tool is sufficient to cause serious injury.

Wooden handles used for hammers, picks, shovels and axes quite frequently are the direct cause of accidents. Care must be taken to use only the best straight-grained material and the handle should be properly fitted and securely fastened in place. When a hammer or ax breaks, some workman may be injured by the flying head, and splintered handles on picks, shovels and sledges often cause lacerated hands.

Keen-edged cutting tools should be sharpened frequently, as sharp tools are safer and more efficient than dull ones. Care should be taken also not to leave tools of this kind lying around where they may be tripped over or stepped on and thus cause serious injury.

Coal production in Arkansas during 1929 amounted to 1,695,108 net tons, according to a statement just issued by the United States Bureau of Mines, Department of Commerce. In comparison with the 1,660,973 t. produced in the previous year, this is a gain of 34,135 t., or 2.1 per cent. Total value of the coal produced by the mines of Arkansas in 1929 was $5,624,000, as compared with $5,615,000 in 1928. The average price per ton, however, shows a slight reduction, being $3.32 per ton in 1929 as against $3.38 in the preceding year. There were 4299 men employed in the coal mining industry of the State in 1929, of whom 3634 worked underground and 665 were surface workers. The average working time was 146 days, the same as in the preceding year.

Escher Wyss & Co. of Zurich has lately secured a contract from the Swiss Federal Railway Authorities for the installation of an electrode boiler plant at the station at Geneva for the preheating of railway trains. The plant will comprise a boiler heated by electrodes taking 400 kw. at 1000 v. and generating steam at 227 lb. per sq. in., also, two steam accumulators each having a capacity of 282 cu. ft.

Smoke Abatement Progress*

Improved Methods for Domestic and Industrial Firing, Fundamentals for Smoke Elimination. By Victor J. Azbe**

SMOKE HAS BEEN a problem from the beginning of man's use of fuel, the problem increasing with centralization of population and industry. From time to time efforts have been made for abatement, but most of them have dwindled out with, at most, a temporary reduction in air pollution. At a result, the public has largely lost confidence and interest, considers the matter as a joke and pays little attention to it except on the few days when atmospheric conditions create an insufferable density.

It is an engineering problem. The method and its application must come from the engineer and there is no good placing the blame on the public. There has been too much compromising. The aim should be *smoke elimination* either by using smokeless fuels or by equipment that enables smokeless firing, regardless of the skill of the fireman.

Smoke Effects

Harmful effects such as dirtying of buildings, equipment, clothing and human lungs, such as cutting off of sunlight with resulting increase of ill health and death rate, such as destruction of vegetation and building materials, are well recognized. Soot emitted in smoke has in general four size ranges; large flakes that fall near their source; medium sized particles that soon settle out of the air current and are easily filtered out; smaller particles which fill our lungs but float in air currents for a long time and make up the smoke blankets over cities; still finer particles, difficult to discern but adding to the cloud and to sooty and tarry deposits on walls and fabrics.

Air stratifies from natural causes, passage from one stratum to another, as well as thickness and condition of strata depending on wind velocities and air temperatures. It is the lowermost stratum into which smoke is discharged, the smoke traveling with it and either moving slowly along near the earth or dispersing upward rapidly according to conditions. As a result, on a day when little smoke is made, air pollution may be worse, if air movement is sluggish, than when much smoke is made but dispersal is rapid.

Measurement of air pollution is, therefore, important but no satisfactory measuring stick has yet been devised. Those proposed give contradictory results; there is disagreement as to methods of taking observations and study is needed, perhaps by an international commission, to evolve a standard method which all can follow so that measurements in different cities and at different times will be comparable with one another. The method should be able to distinguish between dust and soot pollution, should take account of excess air in the chimney gases, should cover acid content, also the effect in cutting off of ultra-violet rays as well as visible light.

Factors for Smoke Elimination

Fundamentals, sufficient but not too much air, sufficiently high temperature to ensure combustion and complete access of air to combustibles are well known to engineers. The problem is to supply these conditions in *all* furnaces since it is probable that some 70 per cent of smoke is due to domestic plants, which have been ignored or exempted from supervision.

In St. Louis, the writer undertook work to evolve a simple method of firing, positive in result, easily controlled, readily adaptable to furnaces at moderate expense, requiring no more attention than ordinary careless methods, yet eliminating smoke without using large amount of excess air. Some 200 tests were made on steam, hot water and warm air plants, covering up-draft, down-draft, with and without secondary air above the fire and with coals of various characteristics. Heavy and light firing were tried with spreading, pyramiding, coking and alternate methods of fuel addition.

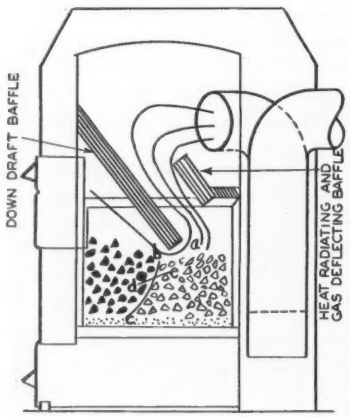
Results showed that the use of a down-draft baffle, Fig. 1, to direct a stream of air towards point *a*, to shield the fresh charge of coal from heat so that volatiles will escape along line *bc* and pass through the incandescent fuel in direction *de* gave little or no smoke, cleaner heating surfaces, greater capacity, less clinkers and ash, longer periods between firings and better results with low grade fuels. Results with and without baffle are shown in Fig. 2, for a small size steam boiler arranged as in Fig. 3. When using the baffle, the rear grate is banked with ashes, the active zone being in front of, underneath and immediately behind the baffle.

Firing is by pushing back the hot coal from the previous firing and filling in green coal in front. For fuel that cakes and swells, a clear space must be left at *b* in Fig. 1 to permit access of air to the gases. If fuel is non-caking or if large lumps are used when it is mildly caking, the front space can be completely filled.

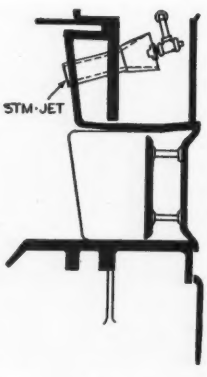
The baffle can be of refractory material about 3 in.

*From a paper before the World Power Conference, Berlin, June, 1930.

**Consulting Engineer, St. Louis, Mo.



FIG·1



FIG·6

FIG. 1. DOWN DRAFT BAFFLE IN WARM AIR FURNACE
FIG. 6. STEAM JET BLOWER FOR OVER-FIRE AIR

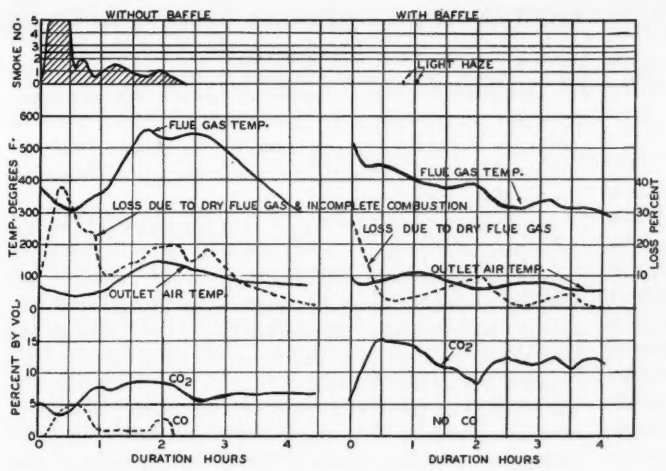


FIG. 2

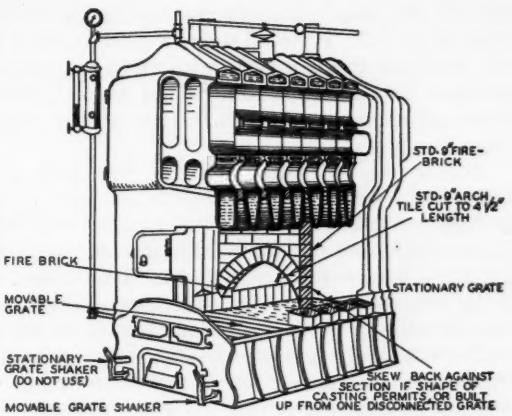

STD. 9" FIRE-BRICK
STD. 9" ARCH TILE CUT TO 4 1/2" LENGTH
FIRE BRICK
STATIONARY GRATE
MOVABLE GRATE
STATIONARY GRATE SHAKER (DO NOT USE)
SKEW BACK AGAINST SECTION IF SHAPE OF CASTING PERMITS OR BUILT UP FROM ONE DISCONNECTED GRATE
MOVABLE GRATE SHAKER

FIG. 3

FIG. 2. PERFORMANCE CURVES FOR STEAM HEATING BOILER WITH AND WITHOUT DOWN DRAFT BAFFLE FIG. 3. ARRANGEMENT OF DOWN DRAFT BAFFLE IN FIRE BOX OF HEATING BOILER

thick or, for small furnaces or stoves, may be of some heat resisting metal such as nickel-chromium-steel alloy.

In starting a fire, coal should be filled into the front space and a wood fire started on top, so that volatilization is gradual. In banking a fire, the volatiles should be burned off before closing down the damper, otherwise a yellow tarry smoke will be given off for several hours.

Power Plant Smoke

To meet the fundamental requirements for smokeless combustion, the chain grate stoker, Fig. 4, feeds small quantities continuously, has a high, properly proportioned arch, large active combustion chamber, shielded where needed, a considerable gas travel and throat contraction that tends to mix heavy gases from the front with those from the back which have excess air. With sufficient draft to furnish air in proportion to coal fired, from this furnace there should never be even a haze of smoke.

With forced draft chain grates, if the furnace arrangement is not right and, with certain fuels, unless over-fire turbulence is created by admitting higher pressure air, preferably preheated, there will be smoke. In one case tested, no matter what one did, dense black smoke was made until secondary air was admitted through the combustion arch. The gas temperature ran as high as 900 deg. and carbon monoxide as high as four per cent.

Much smoke may be caused by air supply not being proportioned to coal feed. With steady coal feed, if the load drops, steam pressure rises, the damper is closed too far, air is insufficient for the coal and smoke results. Burning of carbon can be checked by reducing air sup-

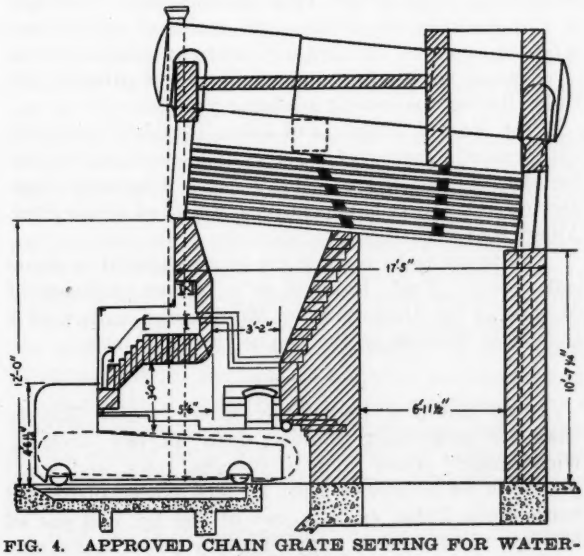


FIG. 4. APPROVED CHAIN GRATE SETTING FOR WATER-TUBE BOILER

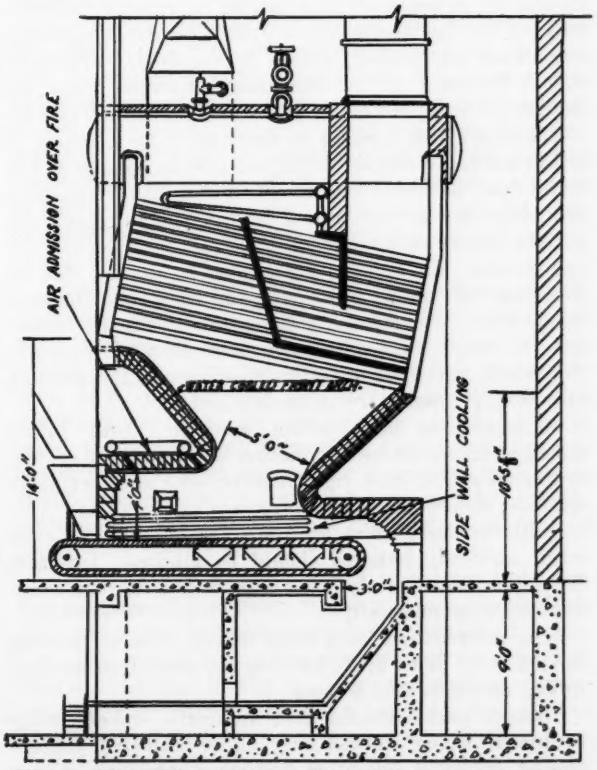


FIG. 5. MODERN LAYOUT FOR FORCED DRAFT CHAIN GRATE

ply but this does not check the distillation of volatiles from fresh coal. Figure 5 shows a modern boiler layout for forced draft chain grate with front and rear arches designed for mixing gases high and low in air and for warm air admission through the rear of the front arch above the fire.

Steam jets, as shown in Fig. 6, are used on Great Lakes boats with hand-fired Scotch marine type boilers to supply over-fire air. The 2-in. pipe is 10 in. long. A ¼-in. nipple and tee are welded into the large end of a 3-in. to 2-in. reducer and a ¼-in. plug drilled with a $\frac{3}{32}$-in. hole acts as an orifice. The blower is set to direct the jet midway between top and bottom of the bridge wall. It is cheap and effiective so long as the fireman turns steam on and off before and after firing. While a steam jet is a compromise, it serves to supply over-fire air and create turbulence, of which a maximum is desirable to break up gas stratification and mix streams low in air with those having an excess.

Ample chimney diameter to allow gas velocity as low as 10 ft. per sec. is advocated by Dr. H. B. Meller to allow dust and large soot particles to settle out. Also, for domestic plants, dust-catchers, similar to cyclones, inserted in the flue aid in preventing air pollution. These are impracticable in large plants.

After enumerating provisions of a number of smoke abatement ordinances, it is stated that their weakness defeats, in large measure, their purpose. The private residence, which in the aggregate is the producer of the greatest amount of smoke, is exempt, so that cheap, smoking equipment is common. Allowance of continuous smoke less than No. 3 density, Ringelmann chart delays clearing of the atmosphere. Complete smokelessness should be required, even when starting or cleaning fires. Education is necessary but letting it replace enforcement of the law accomplishes little. Smoke equipment, even when mishandled, should be required. Provision should be made for an adequate inspection force by charging for the inspection of plants, boilers and stacks.

To enable the fireman to know what he is doing, a smoke indicator, whose indications can be seen from the firing floor, is needed and is required by the Pittsburgh ordinance for all power and heating plants except in private houses or apartment buildings of less than six apartments. It would be desirable to extend this to dwellings for, unless residences stop smoke making and smoke haze from chimneys is barred, it will be impossible to reduce smoke pollution more than 50 per cent. The small, numerous offenders must receive the greatest attention, if results are to be obtained.

Compromises have gotten nowhere. Only effort aimed at entire smoke elimination will be effective. An ordinance should have rigid requirements and be rigidly enforced somewhat as follows:

Only furnaces which are smokeless or nearly so even when carelessly handled should be allowed. Up-draft should be allowed only when coal is fed in very small quantities automatically.

For intermittent hand firing in any furnace, burning should be by down draft baffle or the underfeed method, unless smokeless fuel is used.

Larger plants should have automatic stokers, other equipment being allowed only under iron-clad guarantees of smokeless operation and even automatic stokers should give such guarantees.

George Westinghouse Memorial to Be Dedicated

DEDICATION of the memorial of George Westinghouse, inventor and founder of the industries which bear his name, will take place on October 6, it has been announced by A. L. Humphrey, chairman of the Westinghouse Memorial trustees.

Invitations are now being sent to hundreds of the most eminent persons in America to attend the affair as guests of honor. Leaders of industry, science, art and education will pay tribute to the genius who conceived the air brake, developed the steam turbine and was the proponent of alternating current, and, as well, created industrial structures to provide the world with the benefits of these vital engineering developments.

The ceremony will include the dedication and unveiling of a bronze group of heroic proportions created by Daniel Chester French, American sculptor. A banquet will be tendered to the invited guests in the evening.

Construction of the Memorial and its dedication is in charge of the following board of trustees: Chairman A. L. Humphrey, president of the Westinghouse Airbrake Co.; A. W. Robertson, chairman of the board; F. A. Merrick, president; E. M. Herr, vice-chairman of the board, all of the Westinghouse Electric and Manufacturing Co.; and John F. Miller, vice-chairman of the board, Westinghouse Airbrake Co.

Erection of the Memorial was made possible by appropriation and subscriptions among 60,000 employes of Westinghouse industries in the United States and other countries. Its location will be the most beautiful spot of Schenley Park, Pittsburgh.

NEW CENTER of adult education in science and engineering will be obtained this fall at Cooper Union, New York City, it is announced by Prof. Albert B. Newman, head of the Department of Chemical Engineering.

Engineers and other industrial scientists throughout the New York area recognize the need of organized study to prevent them from falling behind the developments in scientific investigation, Prof. Newman says. Members of the faculties of colleges and technical schools are expected to enroll in advanced evening lecture courses in chemical engineering and physics to be given at the Union during the coming academic year.

Prof. Karl F. Herzfeld of Johns Hopkins University will present a survey of the field of modern physics under the auspices of the Department of Chemical Engineering and the Department of Physics, of which Prof. Albert Ball is the head.

The topics to be covered are closely related to chemical theory. Prof. Herzfeld is a former professor of physics in the University of Munich and author of a treatise in German on the kinetic theory of heat.

IOWA RAILWAY AND LIGHT CORP., Cedar Rapids, Iowa, is progressing rapidly upon its new 2500-hp. Diesel engine power plant at Nevada, Iowa, and is expected to be in service Nov. 1. The power plant will house three Diesel engines, two of 880 hp. and one of 660 hp., to be used as supplementary power units with steam plants in the vicinity to handle peak loads.

Electricity---What It Is and How It Acts*

PART XLIV. PARAMAGNETIC AND DIAMAGNETIC SUBSTANCES. THE ELECTRON THEORY OF MAGNETISM. BY A. W. KRAMER

WHEN WE THINK OF magnetic substances, ordinarily we think only of iron or steel, that is, of one of the so-called ferromagnetic materials which are strongly magnetic. We are not in the habit of associating water or gas or mercury with magnetism, in fact, such things are usually thought of as being essentially non-magnetic. Where a ship such as the "Carnegie" of the Smithsonian Institution is to be used for magnetic observations, it is constructed entirely of wood and copper because these materials do not affect the delicate magnetic instruments on such ships.

This customary differentiation between magnetic and nonmagnetic materials is one which is true only in degree for magnetic properties are not restricted to the iron group of elements. Nearly all substances are acted upon by a magnetic field though to a much smaller extent than iron. Such elements as gold, copper, oxygen and such compounds as air and alcohol have magnetic properties which may be measured and detected by suitable instruments, and which react when subjected to the action of an external magnetic field.

It is found, however, that different substances do not behave in the same way when placed in a magnetic field. Iron, we know, is attracted when placed near a magnetic pole, as is also steel and nickel. Water, sulphur, copper and many other substances, on the other hand, are repelled by a magnet pole, though the force is very much smaller than in the case of iron. Certain other substances, such as oxygen, air, platinum are attracted like iron but to a very much smaller extent than iron.

DIAMAGNETISM AND PARAMAGNETISM

Thus, by their action in a magnetic field, it is possible to arrange different materials in certain definite classes. Those substances which are repelled by a magnet pole or which when placed in a magnetic field become magnetized in a direction opposite to that of the field are called *diamagnetic substances*. Bismuth, water, sulphur, alcohol, zinc, copper, silver, gold and mercury are in this class.

Those substances which become weakly magnetized in the same direction as that of the field in which they are placed and which are attracted by a magnet pole are called *paramagnetic substances*. Oxygen, air, manganese, chromium and platinum belong to this group.

Iron and steel and a few other substances may be placed in a third group, that is, the *ferromagnetic* group. These also become magnetized in the same direction as the applied field but the magnetization is very much stronger than in the case of ordinary paramagnetism.

In general, diamagnetic substances are repelled by a magnetic pole and tend to set themselves at right angles to the lines of force while paramagnetic substances are attracted and tend to set themselves along the lines of force.

Any theory of magnetism to be successful, therefore, must be able, not only to account for the ferromagnetism with which we are most familiar, but must also account for dia- and paramagnetism. As early as 1845, Faraday distinguished between diamagnetics and paramagnetics and he rather favored a conduction theory according to which the magnetic lines tended to crowd into a substance whose conducting power was higher than that of its surroundings. Paramagnetics offered an easy passage to the lines of force while the conducting power of diamagnetics was low.

While there is still much that is uncertain and while no perfectly complete theory of magnetism is available today, magnetic phenomenon can be accounted for partially at least, on the basis of the electron theory. The same electron which has been so useful in explaining the action of electricity and in accounting for the properties of matter, we find now is of use in explaining the mysterious property of magnetism as well. This in itself is a corroboration of the electron theory itself for it is evident that if a single factor is successful in explaining two phenomenon so closely related as magnetism and electricity, the theory involving the use of that factor (the electron) must be correct in itself.

THE ELECTRON THEORY OF MAGNETISM

As was pointed out in the preceding article, the magnetic effect of a single revolving electron can be regarded as the absolute unit of magnetic strength, since the single revolving electron constitutes the smallest electric current possible to imagine. We know that a magnetic effect is produced by an electric current; hence, the smallest magnetic effect would be that produced by the smallest electric current. This smallest magnetic effect (moment) of a single revolving electron is called the Magneton. It represents the absolute unit of magnetism just as the electron is the smallest unit of electricity.

Consider a magnet, any kind of a magnet, cut up into small pieces. Each piece, as has been shown, will be a magnet in itself with respective "north" and "south" poles. Suppose each of these little magnets in turn to be divided into still smaller pieces. If this process is continued, we shall rapidly arrive at a point where the magnets will be scarcely visible; yet they will be magnets. It is an easy matter to conceive the process of subdivision as being continued progressively until the dimensions of the magnets are those of the individual atoms.

Let us picture a single atomic magnet of this kind. For purpose of discussion we may choose the simplest case, that is, the hydrogen atom which consists of a positive nucleus with a single revolving electron around it. This is illustrated in Fig. 1. Since the moving electron constitutes an electric current, a magnetic field will be established as shown.

Since we know the charge of the electron[1] and its

*All rights reserved.

[1] 4.774×10^{-10} electrostatic units.

mass, as well as its velocity, it is possible to calculate the magnetic force or moment of such an atom in a comparatively simple manner. It is unnecessary here to follow through the mathematical reasoning[2] heading to the numerical determination of this moment, but it is of interest to know what its value is. Naturally, it is very small: expressed in gauss it comes out 9.21×10^{-21}. The gauss is the unit of magnetic flux density; a density of one gauss being equivalent to one line of force per sq. cm.

This extremely small unit of magnetism is known as the Bohr Magneton because it is based upon the Bohr theory of the atom. An interesting fact in regard to the determination of this unit, is that it is derived without considering the special constants of the atom in question. Neither its nuclear charge nor the radius of the electronic orbit need be known. Another interesting fact about it is, that although its value was determined from purely theoretical considerations, it has been subjected to experimental verification and found to agree almost exactly with the experimental results. By noting the deflection of an atomic ray in an inhomogeneous magnetic field, the magnitude of the magneton may be determined and it comes out 9.2×10^{-21} a value identical with the calculated value.

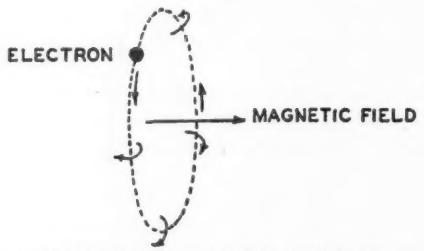


FIG. 1. A SINGLE ELECTRON ROTATING IN A CLOSED ORBIT PRODUCES AN EQUIVALENT MAGNET HAVING A MAGNETIC MOMENT OF ONE MAGNETON

This theory of the magneton based upon electronic orbits according to the ordinary classical theory of Maxwell was beset by one great difficulty, the explanation of the constancy of these electron currents. Classical theory demanded that the energy of these revolving electrons be dissipated. In other words, the existence of such continuously revolving electrons postulated the existence of nonresistant (perfect) conductors.

With the general acceptance of the quantum theory, however, these difficulties were at once swept aside, for the quantum hypothesis together with the Bohr theory postulates the existence of such revolving electrons as a basis for the theory of atomic structure. According to modern theory, the atom radiates or absorbs energy only when an electron is displaced from one orbit to another,[3] but not when in its steady state of rotation around the nucleus. Thus the magneton becomes the unavoidable consequence of modern atomic theory.

Since a single electron revolving around a nucleus produces a "unit" magnetic field, it may be assumed and with good reason that for higher atoms with a greater number of electrons, each individual electron generates such a current of equal magnetic moment.

This does not imply, however, that the total magnetic moment of such an atom is equal to the sum of the moments of the individual electrons, for as is no doubt the case in most instances, when the direction of two revolving electrons oppose each other, their magnetic effects are neutralized. One electron may rotate right-handedly while the other, right-handedly about the nucleus; furthermore, the planes of their orbits may be inclined to each other.

The magnetic moment, that is, the external magnetic effect of a complex atom, therefore, is equal to the resultant of the moments of the individual electrons. It is entirely possible and so far as our knowledge of individual atoms is concerned, it is likely that the electrons occur in pairs, the orbits running counter to one another in consequence of which an atom with an even number of electrons within its structure will give no evidence of a magnetic moment, exteriorly.

The magnetic moment, that is, the degree of external magnetic field exhibited by an atom, thus, is a function not of the total number of electrons revolving within it, but of the difference between the total number revolving in one direction and those revolving in an opposite direction. It depends also, of course, upon the angles at which these orbits are disposed relatively to each other.

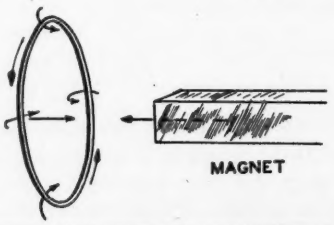


FIG. 2. WHEN A MAGNET IS APPROACHED TO A CONDUCTING RING THE MAGNETIC FIELD CREATED BY THE INDUCED CURRENT WILL OPPOSE THE FIELD OF THE MAGNET

Action of Magnetic Field Upon Atomic Magnets

Let us leave this question for a moment, however, and try to picture what goes on when a single electronic orbit is placed in a magnetic field, or first, let us assume that a closed electric circuit, a ring of copper, say, in which no current is flowing, be placed in a magnetic field. We have seen that a current can be introduced in such a loop by the establishment of a magnetic field which passes through the loop. The electrons are acted upon by a force due to the establishment of the field as explained in Chapter XIV, which lasts while the field is being established but *ceases when the field becomes steady.*

[2]The hydrogen atom, mechanically is similar to a rotor whose mechanical moment of momentum is derivable from the mass of the revolving electron M, its orbital radius a, and the angular velocity w according to the following equation:

$$J = w\ M\ a^2$$

From the same magnitudes, substituting only the charge of the electron e for its mass M, the magnetic moment of the circular current produced by the rotating electron may be determined by the equation

$$m = e \cdot w/6.28 \cdot 3.14a^2$$

in which the factor w/6.28 is the number of revolutions made per unit time and $3.14a^2$ the circumscribed surface. Evidently, also, m and J are related as

$$m = \tfrac{1}{2}\ e/M \cdot J$$

The moment of momentum is further conditioned upon a definite requirement postulated by the Quantum theory: the moment of momentum is equal to h/6.28 or to some whole multiple of it, where h is Planck's constant. Or $m = \frac{1}{2}\ e/u \cdot nh/6.28 = e/u \cdot nh/4$. Taking $m = 1$, $m = e/u \cdot h/4$. Thus, to determine m, all that is needed is the ratio e/u, the specific charge and Planck's constant. Substituting these respective values, $e/u = 1.77 \times 10^7$ and $h = 6.53 \times 10^{-27}$, we obtain for m the value, $m = 9.21 \times 10^{-21}$ gauss.

[3]Chapters XXVI and XXVII, Aug. 15, 1929 and Sept. 1, 1929 issues respectively.

This point must be definitely understood. Once set in motion in this manner, the inertia of the electrons would maintain their flow without diminution, if no retarding action existed. But, as explained in Chapters XIII and IX, the electrons collide with the atoms of the solid conductor and so lose their energy. The originally directed energy of the electrons is thus rapidly transformed into random kinetic energy of the atoms and molecules constituting the conductor. The conductor is heated and when the process is completed, the current ceases.

It is seen, then, that if the conception of continuously revolving electrons in atoms is to hold, it must be assumed that they are unimpeded in their flow—that is,

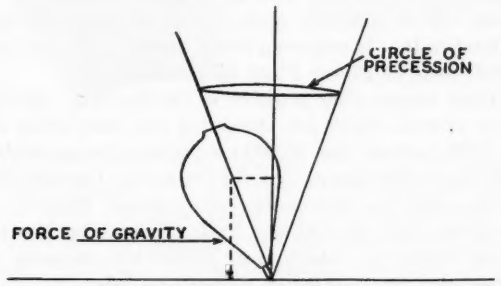


FIG. 3. A PRECESSION OF A SPINNING TOP DUE TO THE ATTRACTION OF GRAVITY

the atomic circuits must be regarded as of zero resistance. An interesting support of the correctness of this assumption is found in the fact that at temperatures near the absolute zero, when the atoms are nearly deprived of their vibratory motions (the existence of which we know as heat) a current induced in a copper circuit will persist for days with little diminution.

Now, from the laws of magnetic induction, we know that if such a loop is moved into a magnetic field, the current induced in the circuit will set up a magnetic field, of such direction as to oppose that of the magnetic pole. If, therefore, a current of electricity is induced in a loop by the approach to it of a "north" pole of a magnet, the law of conservation of energy requires that the field produced by the induced current must oppose the magnet; for mechanical work done on the magnet is the only source of the electrical energy represented in the induced current. When viewed toward the approaching pole, the current in such a loop flows right-handedly around the circuit.

[4]In the same way, an electron already circulating right-handedly in an atomic orbit, relative to the imposed field, will have its speed increased by an increase of the field. If, on the other hand, it is circulating left-handedly, its speed will be reduced. In the former case, the north pole of the atomic magnet is pointed to the imposed field while, in the latter case, the atomic magnet is co-directed with the imposed field. In the latter case, its magnetic moment is decreased but so long as the moment is not reversed in sign, the imposed field does not tend to reverse the magnet.

If, however, the applied field is increased to such an extent as to cause a reversal of the atomic magnet, the condition obviously is the same as in the former case.

Thus, under the forces present, the atomic magnet tends to orientate itself from its alinement oppositely to the field, in other words, the atomic magnet tends to turn so that its field is directed the same as the imposed field. Any movement from the position of symmetry brings into play a magnetic torque which, however, is opposed by the inertia of the revolving electrons. The result is that instead of a simple orientation end for end of the atomic magnet, an axial spin takes place and precession[5] ensues.

The action is exactly analogous to that of a top and precessing stably around an unstable position. The top does not fall over under the pull of gravity and the electronic orbit does not invert itself relative to the field. It remains orientated reversely, with its magnetic axis pointing on the whole opposite to that of the field in a statically unstable position, that is to say, at rest it could not remain so pointed but under the gyroscopic action of the revolving electrons, it maintains its general direction despite the forces tending to turn it around.

In order to understand this, consider a simple gyroscope as shown in Fig. 4. In a way, this gyroscope can

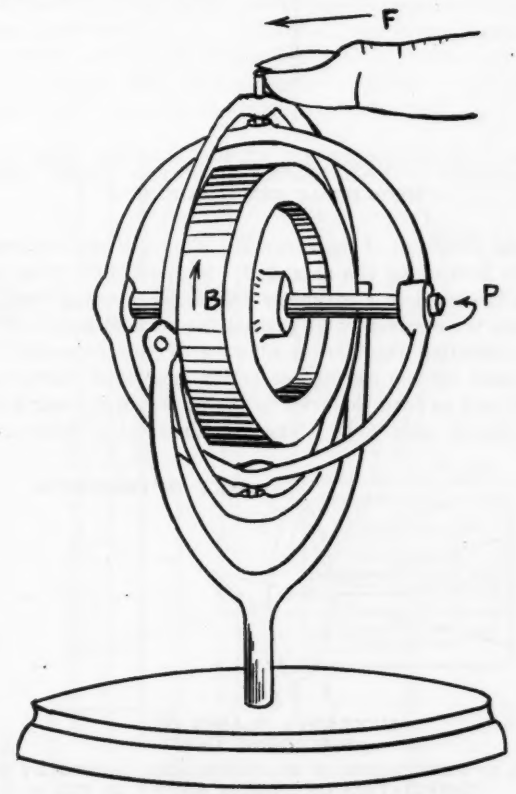


FIG. 4. A SIMPLE GYROSCOPE
If the wheel is rotating in the direction B a force applied in the direction F will cause the axis of the wheel to turn horizontally in the direction of P

be compared to an atomic magnet. The wheel in Fig. 4 is mounted so as to have three degrees of freedom, and as shown, is set with its spinning axis horizontal. On spinning the gyroscope wheel in the direction indicated by the arrow B and applying a force F to turn the gyroscope about the horizontal axis, it will be found that there is a great resistance to the force, and instead of motion taking place in the direction of the applied force, that the wheel turns around in the direction of the

[4]Molecular Magnetism, by W. Peddie.

[5]Precession is the gradual rotation of the axis of a revolving body around a center.

arrow P and will continue to turn in that direction during application of the force until the plane of spin of the wheel coincides with the plane of the force. The wheel not only ceases to turn in the direction of the arrow P, but the resistance to the applied force F also ceases, and accordingly the gyro will be turned about its horizontal axis by the force F.

Consider now the atomic magnet shown in Fig. 5. It consists of an electron rotating around the axis A-B

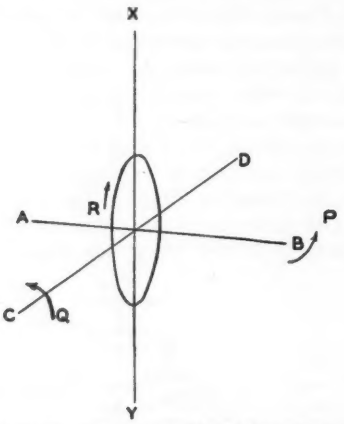


FIG. 5. DIAGRAM OF AN ATOMIC MAGNET WITH THE DIRECTION OF THE FORCES INDICATED WHEN ACTED UPON BY AN EXTERNAL FIELD

in the direction of the arrow R. This will create a magnetic field along the axis A-B. Suppose, now, this system is placed in a magnetic field such as would tend to rotate the electron orbit around the vertical axis X-Y in the direction P. The application of this force will be opposed by the gyroscopic action described above and will tend to turn the orbit in the direction Q around the horizontal axis C-D. The combination of these two

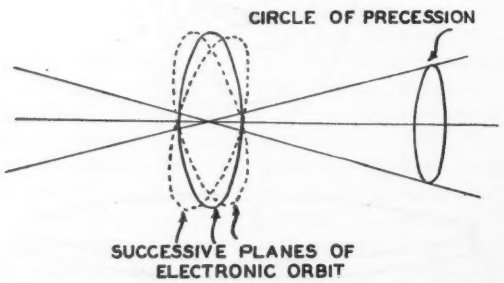


FIG. 6. PRECESSION OF MAGNETIC AXIS CAUSED BY THE COMBINATION OF FORCES SHOWN IN FIG. 5

forces, therefore, will cause the end of the C-D axis to describe the circle shown in Fig. 6. This is known as precession. Thus the C-D axis, will, in spite of the opposing force, remain pointed in the general direction of the opposing force.

Thus we have a fairly logical explanation of the phenomenon of diamagnetism, although this is by no means the whole story. In the case of a simple atomic magnet, the reaction between the magnetic moment of the electron and the imposed field probably is much stronger than the gyroscopic action here described and the field would probably be able to turn the magnet completely around.

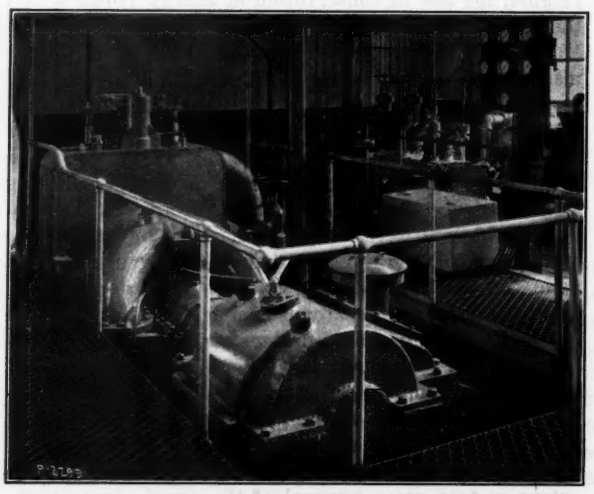
The actual atoms and molecules of a magnetic material are much more complicated than the simple element here described and in the next article an attempt will be made to show more fully what we think goes on in an atom of that kind. The explanation here given, was presented primarily with the view of giving the reader a picture of how these various forces react.

HALFORD ERICKSON, vice-president in charge of operation, Byllesby Engineering and Management Corp., Chicago, Ill., announces that the James H. Reed steam electric generating station of 60,000 kw. capacity on Brunot Island in Pittsburgh of the Duquesne Light Co. will be completed and turned over to the operating department for trial operation on or about October 1. The station will be officially opened and formally dedicated on October 16. It was completely described in the April 1, 1930 issue of Power Plant Engineering.

Other engineering projects in the Byllesby managed utility system which are scheduled for completion during 1930 include the 30,000-kw. station being built at Belle Isle in Oklahoma City for Oklahoma Gas and Electric Co., and the Minnesota Valley Steam Electric Station being built at Granite Falls, Minn., for Northern States Power Co., which is of 20,000 kw. capacity and is scheduled for completion during the fall.

Completion of the James H. Reed station makes a total of 70,000 kw. in steam electric generating capacity completed and placed in service since the first of this year. This figure includes completion of an addition of 10,000 kw. capacity to the Coos Bay station of Mountain States Power Co. at North Bend, Ore.

Announcement has been made also that work will start about November 1 on the installation for Northern States Power Co. of 35,000 kw. additional generating capacity at the Riverside steam electric generating station at Minneapolis. Completion of this project will give the Riverside station a total capacity of 107,000 kw. and with other construction now in progress, Northern States Power Co. will have total installed generating capacity of 436,060 kw.



A 1400-HP. geared turbine drive, in which it is claimed the first all-welded steel gear case was used, has been installed on the American Dredging Co.'s dredge "New Jersey" by the Westinghouse Electric and Manufacturing Co. Because the all-welded construction provides a lighter and stronger gear case, it has become standard practice for dredge installations.

The Industrial Switchboard of Today

By ALFRED C. FINNEY
Switchgear Department,
General Electric Co.
Philadelphia, Pa.

Part II

LOOKING AGAIN at the front of our typical switchboard shown in Fig. 1 of the preceding article, we find on each generator panel the equipment needed by the operator for proper switching and control of the generator circuit. These manually operated controls are usually located within easy reach for convenient operation near the central part of the panel.

LOCATION OF EQUIPMENT

Location and size of the devices to be operated will indicate whether they should be direct manually operated or remote electrically operated. The tendency in recent years has been increasingly toward ease and convenience in operation. The power house is usually built with the main purpose of supplying motors on all machine tools and other labor saving devices in the industrial plant. It is therefore only natural for the switchboard operator to appreciate these advantages and to expect similar provision for letting motors do his heavy work.

For hand regulation of the generator voltage, a generator field rheostat is provided and is operated from either a handwheel and chain mechanism or from a suitable control switch. An exciter field rheostat is also operated from a handwheel which may be concentric with the mechanism for generator rheostat. It is customary to keep rheostat losses to a minimum by using the exciter field rheostat as far as possible for regulation, although a certain amount of resistance in the generator field circuit may give a better operating point on the exciter, especially during times when manual regulation is desired.

A field switch has for many years been considered a standard part of a generator equipment. This gives a ready means of quickly opening the field to kill the generator voltage. As the field is disconnected from the exciter, it is thrown across a discharge resistor which dissipates the effect of this highly inductive circuit and reduces arcing at the switch contacts. For generators of the smaller sizes having direct connected exciters or individual belted exciters, the field switch is not so necessary. When the generator is shut down, the exciter will die down with it. Also, if it is desired to kill the voltage with the machine still up to speed, it is only necessary to turn the rheostat to the "all in" position. This will accomplish the desired results without opening the field. It is therefore considered good practice to omit the generator field switch except where required for disconnecting from a source of excitation separate from the generator unit or where needed with protective relays. In the latter case, an electrically operated or at least electrically tripped field switch would be used.

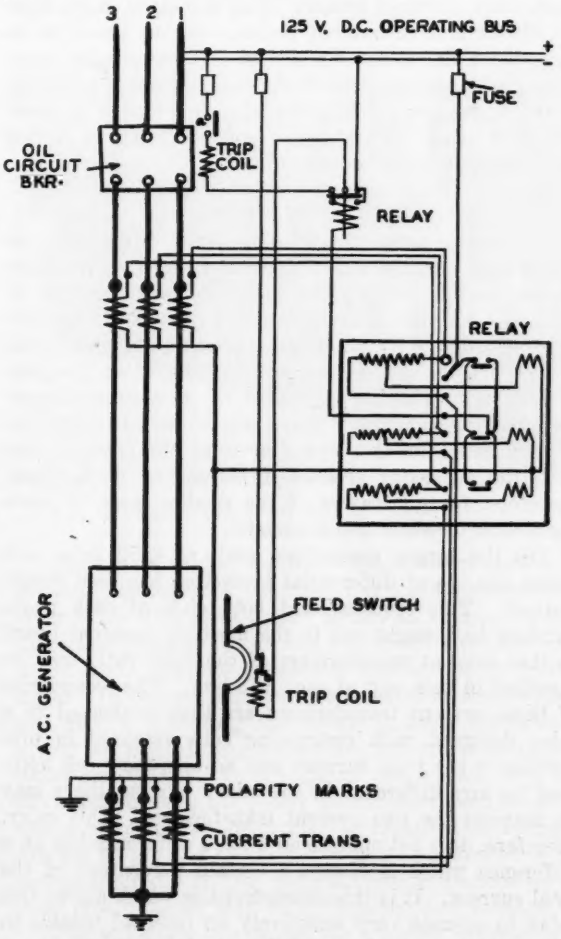


FIG. 1. DIFFERENTIAL PROTECTION FOR AN A.C. GENERATOR

*Switchgear Dept. General Electric Co.

When manually operated field switches are included with generator equipments, it has been customary to mount them "back of board" with an operating handle on the front. Electrically operated field switches allow location near the machine and, if the generator field rheostat is also electrically operated, it may be possible to save a considerable length of cable for field leads. The electrically operated field switch is controlled from a single-pole, double-throw, normally-open type of control switch with indicating lamps to show its position.

Speed regulation of the generator is usually accomplished by some form of mechanical governor on the prime mover. If this governor is provided with a motor speed adjustment, it may be readily controlled by a governor control switch on the panel. The most common motor for this purpose is the split series field d.c. type requiring only a single-pole, double-throw, normally-open control switch for running in either direction.

Connection of the generator to the buses for proper insulation and interrupting capacity usually requires an oil circuit breaker, although in some cases, on low voltage equipment, air circuit breakers may be used. The control on the front of panel will consist of an operating handle for a manually operated breaker or a single-pole, double-throw, normally-open control switch for an electrically operated breaker. This is located in the most prominent and convenient position on the panel as its importanee demands. In the case of electrically operated breakers, connection of the closing control is carried through one pole of the synchronizing switch to make sure that synchronizing is not overlooked before closing the generator circuit onto the bus.

Protection

Automatic protection of generators will depend on the characteristics of the generators and their prime movers, and on the importance of continuous service. It is usually considered preferable to allow outside troubles or overloads to be taken care of on their individual feeder circuits rather than by shutting down the generators and penalizing other feeders. Generators as now designed will generally stand short circuits until the proper feeder breaker opens or until the operator can open the generator breaker if necessary. It is usual, therefore, for generators of the smaller sizes, to leave the circuit breakers non-automatic.

On the larger generators, such as 3750 kv-a. and above, the use of differential protection has been standardized. This requires that both ends of each phase winding be brought out to the machine terminal board so that current transformers of the same ratio may be installed in each end of each winding. The secondaries of these current transformers are then connected to a relay designed with restraining coils actuated in proportion to the total current and an operating coil actuated by any difference in secondary current there may be between the two current transformers. This relay, therefore, does not operate on a fixed difference but on a difference which is always a certain percentage of the total current. It is this characteristics which allows this relay to operate very sensitively on internal trouble in the generator, causing a difference in the currents at the two ends of a winding, while it strongly holds its contacts open in case of external trouble which the feeder breakers should take care of.

As the operation of the differential relay is a practically certain indication of trouble in the generator or its terminal connections, it is desirable to kill the field quickly to prevent further damage after opening the generator breaker. The relay is therefore connected, through a hand-reset auxiliary relay, to trip the electrically operated field switch at the same time as the oil circuit breaker. A diagram of such connections is shown in Fig. 1.

This type of protection has given such good results that it is being recommended also for smaller machines on which the neutral leads are brought out and which are considered important enough to warrant the additional equipment.

Station lighting and auxiliary motors may be taken care of along with the general light and power for the manufacturing plant, but it is also common practice to use a small transformer bank for this purpose, stepping

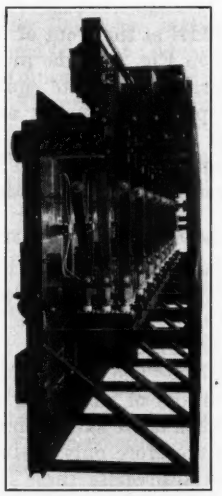


FIG. 2. ARRANGEMENT OF EQUIPMENT IN REAR OF A SWITCHBOARD MADE UP OF ASSEMBLED UNITS

down from the generator bus to a lower voltage. A panel is provided for the control of such a transformer. As additional panels are not usually required for this purpose, the panel is located near the center of the board where it will not interfere with extensions in other circuits.

An ammeter with a three-way ammeter transfer switch is usually sufficient to indicate the load on the small station service transformer, supplemented by the record of a watthour meter. An oil circuit breaker on the primary is operated from the switchboard, while the secondary may be run direct to various distribution panel boards, etc. Overcurrent relays to trip the oil circuit breakers should give sufficient protection.

For a synchronous motor, the minimum instrument equipment is an a.c. ammeter to indicate the load on the machine causing heating and a field ammeter to make sure of proper rheostat setting. With several synchronous motors on the same bus, the field ammeter will also give indications to the operator so as to hold the predetermined field required in making the machines take their share of the reactive load. When motors form part of a motor-generator set, as in this case, it is a simple matter to use them in part for counteracting

poor power factor on the system. A reactive volt-ampere meter on each motor panel will then show just how much each motor is helping in this way and adjustment of the field may be made to suit conditions. When the power load on the motor is important, an indicating wattmeter may be added. A complete record of certain factory operations is often useful and for this a recording wattmeter furnishing a continuous strip record of load is a valuable addition. Total power used is also shown by a watthour meter, and load factor may be calculated.

Switching control for a synchronous motor must provide for starting as well as running. A motor-generator set is usually started on reduced voltage taps of an auto-transformer, the synchronous motor having an extra "amortisseur" winding so as to act temporarily as an induction motor. Two non-automatic oil circuit breakers are used in starting, one to connect the auto-transformer to the line and the other to close the Y point of the auto transformer. The motor is connected directly to the lowest tap on the compensator that will give sufficient starting voltage. Or, if the Y point of the auto-transformer is not brought out, the second oil circuit breaker may be used to connect the motor to the starting taps. In either case, the two breakers are operated simultaneously and are left closed until the machine comes up to practically synchronous speed.

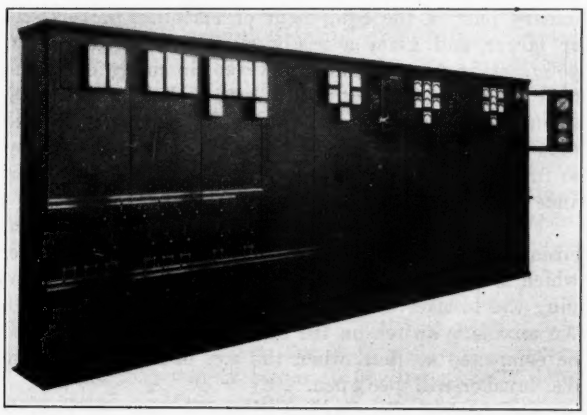


FIG. 3. FRONT VIEW OF A SELF CONTAINED STEEL SWITCHBOARD

In switching over to full voltage, the starting breakers must be opened and the running breaker closed with as little delay as possible to prevent slowing down of the machine. This is assured by a time limit interlock in the case of manually operated mechanisms, while electrically operated breakers are interlocked by an interlocking relay and auxiliary switches. In either case, the operation is such that the running breaker can only be closed immediately after the starting breakers have been closed and opened again. This avoids short-circuiting the auto-transformer and also prevents throwing the motor directly on full voltage in starting.

A field switch is ordinarily used with synchronous motors of this size. This is usually a double-pole switch so as to disconnect the field completely from the excitation source. In opening, the field is connected across a discharge resistor to take up the inductive "kick" of the field and reduce arcing. During starting the field switch is in most cases left in the discharge position, to give proper starting characteristics and to minimize the induced potential in the field. The stator and field windings of the motor act as the windings of a transformer until the machine comes up to speed. Even with the discharge resistor across the field, a considerable voltage is induced and it is advisable to isolate the field switch. One good way of doing this is to mount the switch back of the panel with the operating handle on the front.

The synchronous motor field rheostat for a machine of this size is usually operated by chain and sprocket and a handwheel is provided on the panel.

Overload protection of the synchronous motor is best covered by the use of inverse time overcurrent relays connected to trip the running breaker only. An undervoltage relay for tripping electrically operated breakers is also desirable, to prevent restarting on full voltage after an outage. A short time delay on undervoltage tripping will avoid unnecessary operation for momentary dips in voltage. In case manually operated breakers are used, time limit tripping may also be obtained as a part of the mechanism for overcurrent and undervoltage as well. Overcurrent relays or tripping devices must be designed to reset quickly as they will probably be picked up during starting, although not connected to trip the starting breakers, and if not reset would trip the running breaker as soon as closed.

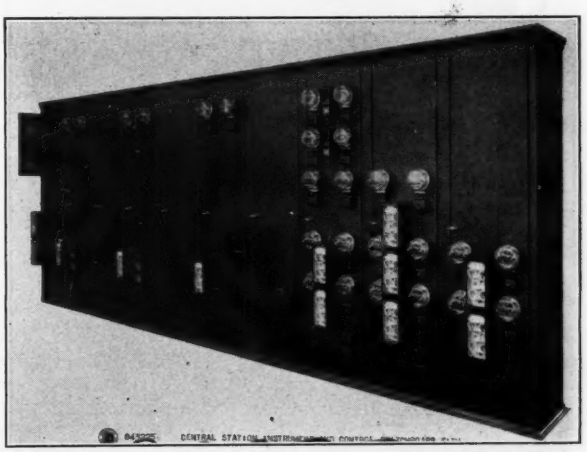


FIG. 4. REAR VIEW OF BOARD SHOWN IN FIG. 3

Each main feeder requires a separate equipment for greatest flexibility of control. For lighting circuits or other loads with good power factor, an ammeter with a three-way transfer switch will give good indication. For motor loads, the power taken is best shown by a wattmeter. In either case, a watthour meter is usually essential and a recording wattmeter is very desirable as giving an opportunity to correct for unnecessary load peaks and valleys. In the case of motor loads, it is also advisable to check the power factor occasionally and for this a power-factor meter may be mounted on swinging bracket at the end of the board and transferred to any circuit desired. In this way, the circuit responsible for poor power factor may be determined and checked up.

The switching equipment for a feeder consists of an automatic oil circuit breaker either electrically or manually operated from the switchboard.

Feeders are protected ordinarily by inverse time

over-current relays. The time and current settings should be such as to allow individual circuits for motors, etc., to open first on overload, leaving the feeder relays to take care of trouble on the feeder itself. This will avoid shutting down all the motors on the circuit for trouble in one motor only.

Arrangement of buses, oil circuit breakers and other equipment back of the board will vary greatly with the station design, and according to whether electrically operated equipment is used or not, and a description would extend beyond the scope of this paper. The equipment required for various circuits, however, has been outlined, as controlled from the front. The rear of a well-arranged switchboard with framework in fabricated units is seen in Fig. 4.

Equipment is also needed to take care of the control

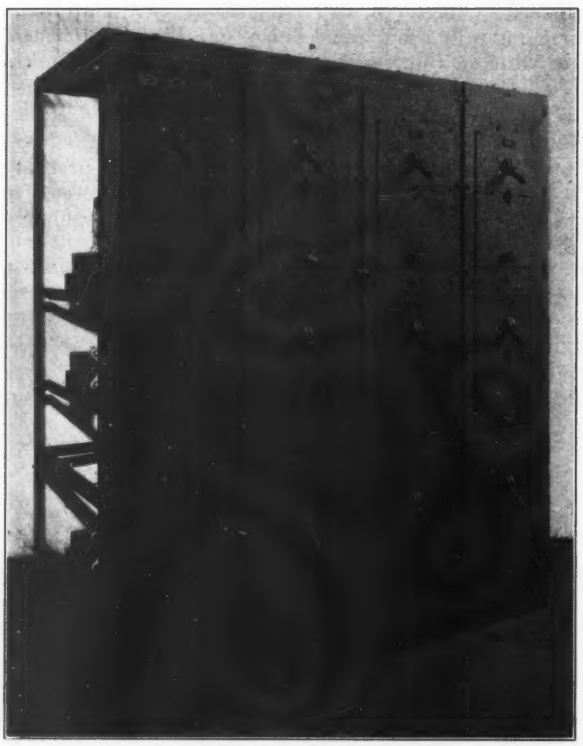


FIG. 5. FRONT VIEW OF SAFETY ENCLOSED DISTRIBUTION BOARD

of the d.c. end of the motor-generator sets. An ammeter gives complete information on the load on the generator, the voltage being held normal according to the voltmeter. One voltmeter is sufficient, being plugged in on either generator. A record of integrated power output on a watthour meter is sometimes desired but this is usually just as well covered by a watthour meter on the a.c. motor end of the set.

Switching and protection are mainly combined in a single-pole overload air circuit breaker. This, in series with a knife switch, connects one side of the generator to one bus and a knife switch connects the other side to its bus. This allows complete disconnection from the bus. It also allows the circuit breaker to be closed and at rest ready for operation in case of overload when the circuit is completed by closing the switch. The use of a breaker "trip-free" from the handle will practically make a switch in series unnecessary, although still desirable as a safety feature.

For parallel operation an equalizer switch, about one-third the capacity of the main switches, is used to connect the generators together between armature and series field. This keeps the compounding effect alike for the different generators, the series fields being connected directly in multiple. The equalizer switch may be mounted on the generator panel as shown or, if preferred, an equalizer pedestal may be used for separate mounting near the machine. In many cases, the equalizer switch is mounted on a base on the machine frame.

A single-pole, single-throw, field switch with provision for discharge, on the front of panel, is a customary part of the equipment of machines of this size or larger and gives a ready means of cutting down potential on the machine; however, in many cases the field rheostat can be supplied with sufficient resistance to cut the voltage down to practically residual value, so that the field switch may be omitted. It is just as easy to turn the rheostat handwheel and causes less disturbance than opening the field switch.

For protection of the set against runaway, the d.c. circuit breakers will include an undervoltage device, which is especially valuable as a reliable means of tripping the breaker from the speed-limit on the machine. An auxiliary switch on the oil circuit breaker may also be connected so that, when the a.c. breaker opens, the d.c. breaker will also open.

For feeders distributing direct current to various load centers, an ammeter will give sufficient indication. For the records of the plant, however, the addition of a watthour meter, or a strip chart recorder is very desirable. These meters can be obtained as shunt type, operating from the same shunt as the ammeter in sizes such as 1000 amp. and above.

The two-wire d.c. feeder is protected by a single-pole overcurrent circuit breaker for connection to the bus, the arrangement of disconnecting knife switches in positive and negative being similar to that for the generator. The use of a double-pole, trip-free circuit breaker will make the knife switches unnecessary.

The foregoing remarks have revolved around an outline of a hypothetical standard switchboard. Individual requirements will always result in something new and original. One of the latest developments in an actually installed board is shown in Figs. 3 and 4. This is of steel formed into a self-supporting structure or series of unit cubicles. Indicating instruments and electric control equipment are found on the front, while remaining equipment, not needed continually in view, is mounted on the back panels, hinged for access to the wiring, etc., in the interior. This is a good example showing the present trend toward compactness, with safety and convenience of control.

The demand for safety to operator and plant investment is further being extended into the distribution system, and low-voltage feeders at different points are taken care of by completely-enclosed, dead-front equipments such as shown in Fig. 5. The switches are mounted with only the handles projecting through a substantial steel front. Fuses are accessible from the front and only when the switches are open. In this case, current and potential transformers for operating watthour meters are also to be seen.

Saving the Heat in Boiler Blowdowns

IN ONE PLANT CALCULATIONS SHOW A SAVING OF 500 T. OF COAL PER MONTH. BY M. D. DAWSON*

IMPURITIES THAT ENTER a boiler with the feedwater remain there in solution until drained out. The concentration of impurities in the boiler increases at a rate depending upon the impurities in the water, period of operation and the rate of steam output.

Much study has been given to systems for the purification of this water supplied to the boilers. In general, there are four systems of purification, mechanical settling, chemical precipitation of impurities, chemical exchange in which undesirable impurities are replaced by relatively harmless chemicals and evaporators producing distilled water for boiler feed.

In power plants where the boilers supply steam for electric generators only, the prime movers are usually equipped with condensers that return the condensate or condenser steam back to the boilers and as a result require little new or make-up water. This type of plant often employs evaporators for purifying the make-up water because the equipment does not have to be of large capacity and the investment is relatively small. Distilled water is, of course, the best for boiler purposes.

Plants that supply steam to heating systems, however, require a large percentage of make-up water, since little or none of the heating condensate is returned. In this type of plant, the water is usually treated with one of the first three methods mentioned above because the cost of an evaporator installation would be unwarranted.

For instance, in the Ashley Street plant of the Union Electric Light & Power Co. at St. Louis, make-up water supplied to the boilers is purified by the use of lime, sulphate of iron and barium hydrate. This system utilizes the principles of mechanical settling and chemical precipitation and has been used for treating Mississippi River water for many years with satisfactory results. There are some impurities in the water, however, that chemicals will not remove and unless the water is distilled these impurities pass on to the boiler.

High Concentration Dangerous

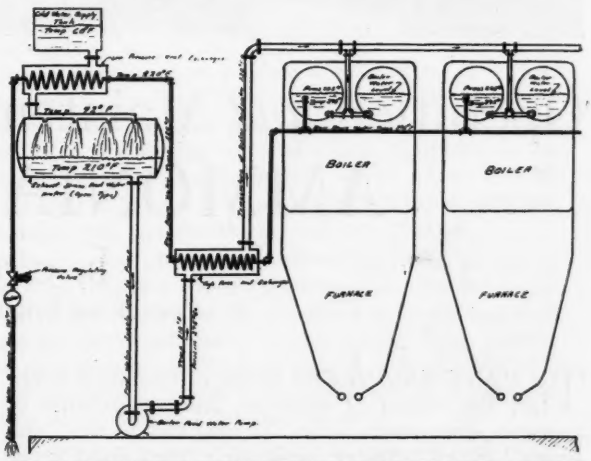
For example, the boilers in the above plant hold approximately 50,000 lb. of water and at times the steam output is 50,000 lb. per hr. If the boiler is operated for 8 hr. under these conditions, concentration of impurities in the boilers will be eight times that of the feedwater or, in other words, the boilers evaporate a complete boilerful of water every hour. It is not only uneconomical but dangerous to operate a boiler with water of high concentration of impurities because the rapid scale formation impairs economy and there is danger of the boiler priming, thus sending over impurities and water through the steam outlet into the steam lines.

The most common method of controlling concentration of impurities in a boiler is periodically to blow down a portion of the boiler water, the quantity being governed either arbitrarily by past practice or more correctly by a daily chemical analysis. By this is meant the process of opening valves on the boiler mud drum and permitting the accumulation of mud and impure water which has settled there to flow out.

This system has proven satisfactory as far as operation is concerned but the heat loss of blowing away hot boiler water has always been objectionable. At Ashley St. about 8 per cent of the water is blown down in this manner and since it is at the high temperature of about 400 deg. F., a great deal of heat is lost. Calculations for a system of periodical blowdowns indicate that there is a 335 deg. F. temperature loss or approximately 335 B.t.u. loss for each pound of water blown down.

Continuous Blowdown Saves Heat

For this reason, a new continuous blowdown system has been adopted at Ashley St. With this system, a small quantity of boiler water is continuously drained from the boiler and passed through the heat exchangers which transfer the heat to the pure water going to the boiler.



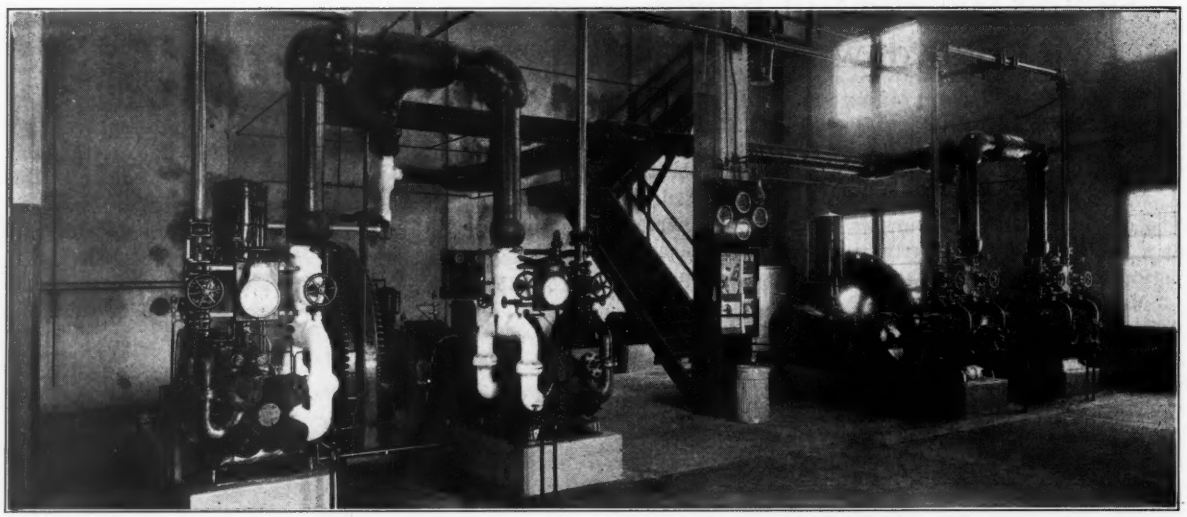
SKETCH SHOWING THE CONTINUOUS BLOWDOWN SYSTEM AS INSTALLED

This arrangement is shown in the illustration. The blowdown water leaves the boiler at 395 deg. F. and then passes through two heat exchangers. The first reduces the temperature to 220 deg. F., the second to 90 deg. F. Cooling medium for these heat exchangers is pure feedwater on its way to the boiler. The low pressure heat exchanger is between cold water supply tank and the open feedwater heater while the high pressure heat exchanger is on the discharge side of the boiler feed pump. The boiler feed temperature is raised to a temperature of 210 deg. F. in the open heater and this is increased to 230 deg. F. in the second heat exchanger or closed heater.

Comparison of the final blowndown water temperature of 90 deg. with the make-up water at 60 deg. shows that there is a heat loss of only 30 deg. for each pound of water blown down with this system as compared with 335 deg. F. for the old system. Calculations indicate a saving of approximately 500 t. of coal per month, effected by the installation of a continuous blowdown system in this one plant.

IT IS SAID that 60 per cent of the output of one Diesel engine manufacturer goes to public utilities.

*Union Electric Light & Power Co., St. Louis. From an article appearing in the Union Electric Magazine.



Operation *and* Maintenance *of* AMMONIA COMPRESSORS

By C. T. Baker
Consulting Engineer, Atlanta, Ga.

TO MANY ENGINEERS in the refrigerating industry, the subject of operation and maintenance of ammonia compressors is an old one, and to the "old-timers" in this industry particularly, the subject is one which they might not elect to devote much time to the study thereof. On the other hand, to the younger men in this branch of engineering, the ammonia compressor, frequently referred to as the "heart of the plant," is of primary importance and it is for this newer generation that the following remarks are mainly intended, since the old-timers, or those who have arrived, obviously are not in need of advice. At the same time, a review of the subject will in no way harm them.

Types of Compressors

In any complete discussion of ammonia compressors, it is well first to classify such machines as to type or style and to consider each particular type as a separate entity, at least within certain limits, since each type requires a somewhat different treatment from the standpoint of operation as well as maintenance.

For many years, there were only two distinct types of ammonia compressors, namely, the horizontal double-acting and the vertical single-acting type. The horizontal double-acting machine of earlier vintage was usually of the single cylinder construction and directly connected to a simple Corliss engine. As the demands for increased capacity and economies developed, this type of machine was frequently built with two ammonia compressors having cross-compound Corliss steam cylinders connected to a common crank shaft with the ammonia compressors. Such machines were described as horizontal double-acting duplex compressors.

In the case of the vertical single-acting compressors, these were built for direct connection to the simple Corliss and later to the cross-compound condensing Corliss engine and both the horizontal double-acting and the vertical single-acting machines were used extensively in ice making and refrigerating work.

Naturally, differences of opinion occurred among owners and operators as to which type of machine possessed the greater merit and even to this late day the question is still somewhat a mooted one in many quarters. Such machines, of course, called for a great deal of engine room space, since, to get the larger capacity at the prevailing engine speeds, large cylinder dimensions were required.

Ultimately, the high-speed compressor appeared which, as built today, is properly classified as the high-speed, vertical, enclosed single-acting compressor and the high-speed horizontal double-acting compressor.

Between the high-speed compressors of the present period and the slow-speed machine of an earlier period there is to be found the so-called medium speed machine which probably strikes a balance between the slow-speed, steam-driven machine and the high-speed electric-driven compressor or Diesel engine-driven compressor so prevalent at the present time. Specific reference will be made to the care and management of the various types referred to later on in this article.

Compressor as a Pump

An ammonia compressor has been appropriately described as a pump; for in effect this is what an ammonia compressor, or any other type of gas compressor, actually is, since gas at low pressure is taken in at the

suction side of the pump and raised to some higher pressure by compression where it may be condensed as in the case of ammonia gas and the liquid again used for the taking up of heat in the lower temperature regions with the resulting gas from the boiling liquid again taken into the compressor, thus continuing the cycle.

It is evident that any pumping machinery, to be efficient, must be maintained in the best possible mechanical condition, otherwise the cost of pumping as reflected in power consumption regardless of the type of power used, will be abnormal and since the item of power is one of the principal items in the production of a ton of ice or a ton of refrigeration, it is obvious that any neglect of the pump cannot help but result in waste.

If the compressor has been placed on a good foundation and has been correctly leveled and lined, it is reasonable to suppose that it will remain level throughout the period of its life barring accidents which might cause a change; however, as regards the reciprocating

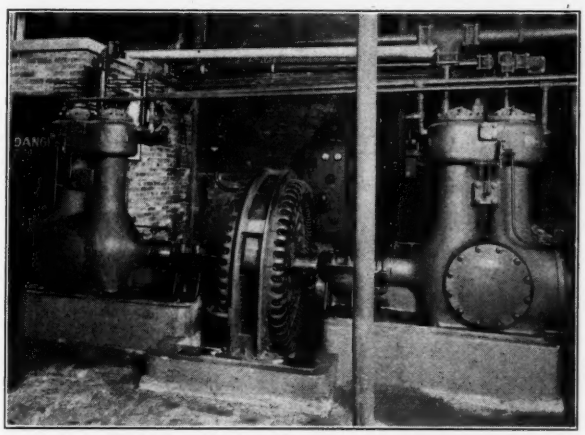


FIG. 1. A TYPICAL ARRANGEMENT OF TWO VERTICAL ENCLOSED TYPE COMPRESSORS DIRECTLY CONNECTED TO A SINGLE SYNCHRONOUS MOTOR

parts, this is subject to change and it is possible for a crankshaft, for example, to be thrown out of alinement or to be thrown out of level due to the wearing or burning of a bearing. It is possible also for misalinement to occur in the crosshead, connecting rod and piston rod assembly, due to neglect or to maladjustment.

A word of advice concerning the necessity for proper adjustment of the reciprocating parts of the machine may not, therefore, be out of place here. Starting with the compressor piston rod and crosshead, it is quite important that the centre line of the crosshead be adjusted central between the crosshead guides regardless of whether the machine be of the vertical or horizontal type.

Unless this is done, the angularity of the crosshead will throw the piston rod out of alinement with reference to the stuffing-box and this in turn will cause serious loss of ammonia, piston rod heating and ultimate scoring and the destruction of expensive rod packing.

When adjusting the crosshead between the guides, the stuffing-box gland should be removed so as to permit the taking of measurements between the rod and inner surface of the stuffing-box. Such measurements are usually made at four points equidistant around the circumference of the stuffing-box. For taking these measurements, adjustable inside calipers or micrometer gages may be used.

For centering the crosshead and piston rod between the crosshead guides, generally a pin stick is used for this purpose. The pin stick is simply a piece of pine whittled to a convenient size with a common pin driven into each end, the distance between the pin heads being the same as the correct distance between the piston rod and wearing surface of the crosshead guides.

In making the pin stick gages, first carefully measure the diameter of the crosshead guide then the diameter of the piston rod which will determine the correct distance from the surface of the guide to the surface of the piston rod. For example, if the guide diameter is found to be 12 in. and the rod diameter 2 in. the correct distance from the guide surface to the rod surface would be 5 in., therefore the pin stick should be made 5 in. or say the thickness of a cigarette paper shorter than this distance.

In centering the rod between the guide and the stuffing-box, care should be exercised to see that measurements are made at no place where the rod is worn or reduced in diameter. This means that all measurements should be made from that portion of the rod which does not enter the stuffing-box and which, therefore, is not worn. Likewise, measurements should be made with the piston in at least two and preferably three positions; namely, head end, crank end and mid-position.

In the case of machines which have been in service for some time and which may have rods that are scored or shoulders worn near the crosshead or piston end, such rods should be returned. If the scoring is too deep or the shoulders too heavy, new rods should be substituted since the saving in loss of ammonia will in a comparatively short time pay for such repairs.

A common mistake made by many operators in adjusting crosshead shoes is to adjust them too closely, with the result that when the machine reaches its normal running temperature, the crosshead expands, causing overheating and oftentimes damage to wearing surfaces. The clearance between the slack side of the crosshead and crosshead guide should be measured with suitable clearance gages and a record made for future reference.

Rod Packing

As to the kind of rod packing to use, that is, soft packing or metallic packing, this is a matter that must be decided by the owner or engineer for each individual case; however, either kind will be found satisfactory when properly installed and cared for. In the case of metallic packing, however, it is absolutely essential that the piston rod be central in the stuffing-box and that the rod be in good condition before such packing is installed. If the reverse is the case, then trouble is inevitable. The writer favors metallic packing in preference to soft packing for most types of compressors, since good metallic packing will generally insure minimum rod leakage and minimum friction loss in the stuffing-box; also, maximum life. Needless to say, machine bearings should be properly adjusted and no undue lost motion permitted at any point.

In the case of the horizontal double-acting machine, the construction of which precludes the use of safety heads as obtain in the vertical single-acting compressor,

improper bearing adjustment might easily result in the piston overtraveling its clearance and striking the head.

For example, the writer recently saw this illustrated in the case of a large motor-driven horizontal compressor which had been started up after adjusting the main bearing and without first turning the machine over by hand to see whether or not everything cleared. In this case, the quarter boxes had been tightened up on one side only and this threw the shaft out of its true position so far that when the starting switch was thrown in and the machine made a revolution, the piston was driven into the crank end head of the cylinder, resulting in a broken frame as well as stripped threads in the crosshead. Such cases are not common but under certain conditions can and do happen, therefore it is important that after bearing adjustments have been made, particularly if much lost motion is to be taken up, the machine be turned over by hand two or three times to make sure that everything clears.

Engineers accustomed to making adjustments will not overlook this important factor; however, the inexperienced operator is liable to make the mistake of assuming everything is all right.

The foregoing discussion concerning the care of bearings and methods of alinement is applicable principally to the horizontal double-acting compressor and the vertical single-acting non-enclosed-type compressor and is not applicable except in a minor sense to the vertical enclosed single-acting machine so common in the refrigerating industry today; however, it is important, of course, that bearings in the enclosed-type compressor be properly adjusted and that suitable packing be used in the stuffing-box joints where the crankshaft passes through the machine housing.

Pistons and Valves

The loss in machine capacity resulting directly from leaky valves and leaky pistons in ammonia compressors is tremendous. In a great many plants, the compressors are indicated at regular intervals and the theoretical curves plotted on the indicator cards which show at once the presence of leakage, if any; however, in all too many plants the indicator is never used and machines are run for years without an examination of the valves or piston rings. If the owners of refrigerating machines who are being penalized by loss in capacity due to compressor leaks ever wake up to the magnitude of this loss, they certainly will waste little time in applying a remedy. It is well known that the capacity of a compressor depends, among other things, upon the weight of ammonia gas pumped in any given time.

Of course the weight of gas handled in any specific time will depend, among other things, upon the suction pressure. With any compressor, the gas handled per unit of time at any stated suction pressure will depend upon the design of the suction and discharge valves, the size and length of the suction piping and other things beyond the control of the operator; however—and this is important—the amount or weight of gas handled per unit of time will also depend upon the condition of the compressor valves and the condition of the piston rings and cylinder.

If the suction valves leak, gas will escape from the discharge end of the cylinder back to the suction side when the pressure in the cylinder is raised slightly above the suction pressure during any discharge stroke. This means then that not all of the gas taken into the cylinder on the suction stroke reaches the condenser during the discharge stroke but a part of it short-circuits back to the suction side without doing useful work. This results in loss in capacity and an increase in the horsepower per ton of output. Leaky discharge valves cause ammonia to escape back to the cylinder after the discharge stroke is completed. This reduces the amount of suction gas that may be taken into the cylinder during any given suction stroke by the amount of gas that can reënter the cylinder through a leaky discharge valve.

Piston rings that do not fit the cylinder walls properly, permit leakage of high-pressure gas between the rings and cylinder walls during the discharge stroke which also has the effect of preventing the filling of the cylinder with gas from the suction line during the suction stroke.

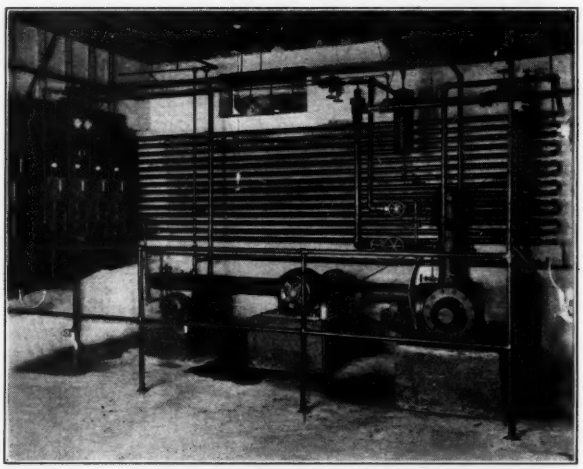


FIG. 2. A COMPACT ARRANGEMENT OF SMALL REFRIGERATING PLANT WITH BELT DRIVE

It is recommended to those engineers not familiar with the use of the ammonia indicator that they secure some practical treatise on this subject and study it in order that they may understand how to use the indicator for taking cards from their compressors and also how to plot the theoretical curves on such cards after they are taken. They will find the ammonia indicator to be one of the most valuable aids at their command for obtaining maximum compressor efficiency.

Necessity for Care in Fitting Pistons and Grinding Valves

Often the writer is told by plant managers that they have spent considerable money on compressor repairs only to find that the anticipated results were not forthcoming. As this complaint seemed all too prevalent, the case of one large operating company was selected for investigation. Briefly, the following facts were discovered. First, considerable money had been expended in machine shop bills for machining and refacing suction and discharge valves; however, these valves had not been ground in afterward so as to make a tight joint but had simply been replaced in the compressors as they came from the shop on the theory that lathe work was close enough to insure tightness.

Likewise, new rings had been fitted to several of the compressors without taking careful measurements to determine the compressor diameter or to indicate whether or not the compressors should be rebored. The result was that no improvement in machine operation occurred.

The writer then indicated the several compressors owned by this company and discovered that in every instance, abnormal piston and valve leakage was occurring.

It is absolutely essential, regardless of how carefully or accurately valve and valve seats may be machine finished, that they be ground in with suitable grinding compound before being placed in service. Likewise, valve cages should be ground to their seats in the cylinder heads and in the case of the vertical single-acting machine, it is important that the safety head be ground in to a good joint also. Great care should be exercised, however, to prevent any of the grinding compound from finding its way into the cylinder, otherwise a scored or cut cylinder will be the result.

In the case of piston rings, they should be made over-size, then properly turned and fitted to the cylinder and to the slots in the piston. It is important also that the edges of all piston rings be beveled or rounded off so as to avoid sharp, square edges. The beveled or rounded ring will permit oil to pass between the ring and cylinder walls whereas the sharp square shouldered ring will tend to scrape the oil away from the cylinder walls, thus causing trouble with lubrication.

Lubrication

Lubrication of ammonia compressors is very important and any one who attempts to obtain correct lubrication by the use of cheap or inferior oils is merely courting trouble. Not a great deal of oil is required to lubricate ammonia compressors properly but unless such oil is suitable, no matter how much is used, the results will be disappointing. For example, an oil that may be used successfully is one that will not congeal at temperatures as low as zero or slightly below and also one that will not decompose at temperatures common in discharge gases. This means that the flash test must be reasonably high and the cold test low.

Any of the reputable oil companies can supply the so-called ice machine oil and if the engineer will supply information to the oil companies' lubricating experts indicating the conditions under which their compressors operate and being careful to advise them of the suction and discharge temperatures, they will supply a lubricant that will fully meet the requirements.

Ordinary lubricating oils will not do and only a straight mineral oil should be used for lubricating the valves, cylinder and rods of ammonia compressors. It may seem like an unnecessary repetition in making the above statement, yet only a few days ago the writer found an engineer using a highly compounded engine oil in an attempt to lubricate an enclosed type refrigerating machine which was operating at 257 r.p.m. and direct connected to a synchronous motor. The result of this attempt would have been disastrous if it had not been discovered in time. As it was, the valves were all gummed up and had to be removed for cleaning and the cylinders, while not cut, were exceedingly dry and would no doubt have been damaged in a short time.

In this instance, the supply of ice machine oil had been exhausted and while awaiting a new supply, engine oil had been substituted.

Program for 5th Midwest Power Engineering Conference

ON SEPTEMBER 11, President H. W. Fuller announced definite acceptance of the tentative program for the Fifth Midwest Power Engineering Conference to be held in Chicago, February 10—13, 1931. In cooperation with Mr. Fuller, the Program Committee, headed by Thomas Wilson, has prepared an outline of the procedure which will assure an assembly of subjects covering a broad expanse of the power field with an intensive interest to all members of the eight national participating engineering societies. The occasion will afford an unusual opportunity in view of the schedule and program of the National Fuels meeting of the American Society of Mechanical Engineers which is to be held simultaneously with the Power Conference.

Opening officially with a luncheon meeting devoted to The Influence of Power on Modern Development and Progress, the Power Conference will continue through six sessions, each covering an important phase of power in a particular field. There will be a session on Power Economics dealing with balancing of plant investment and the advance in electrical development, from the standpoint of design, construction and operation.

An evening meeting on refrigeration and ventilation will feature recent applications of refrigeration in air conditioning and the power requirements in the cold storage industry. Under the heading of Prime Movers a session has been arranged which will be devoted to trends in the development and application of steam turbines, reciprocating engines, Diesel engines and water turbines of the propeller type.

In the electrical field a session has been arranged of decided interest. Papers will include such important and popular subjects as Electrical Pumping of Oil, Electrical Arc Welding and High Voltage Direct Current Transmission. Men of outstanding prominence are being asked to present these subjects in a comprehensive way.

In view of the great importance of all water problems in the power plant, a session has been arranged which will bring out late developments in the pre-treatment of boiler feedwater, recent evaporator practice and design, and concentration control.

For the final sessions a tinge of local color has been injected for, while the session will be devoted to problems of the civil engineer covering natural reservoir power resources and geology, the popular side has been stressed in a paper covering the engineering features, both power and otherwise, of the Chicago Subway situation.

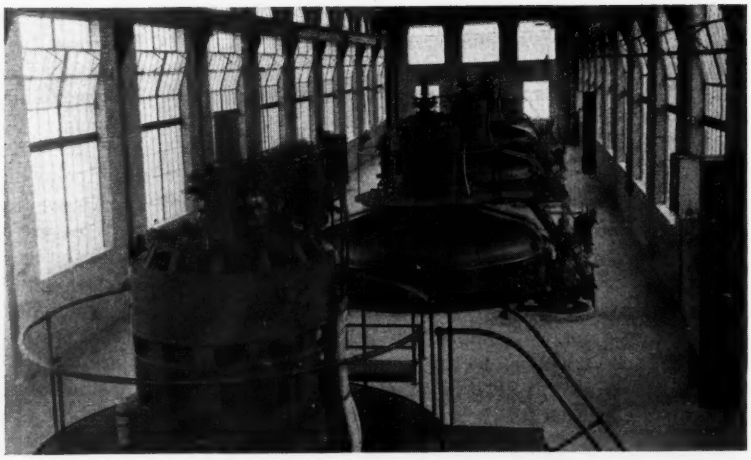
In connection with the entire meeting of the Power Conference and the simultaneous sessions of the National Fuels Meeting, will be the Fifth Midwest Engineering & Power Exposition covering over 85,000 sq. ft. of floor space at the Coliseum, available the entire week for the inspection of equipment and services of approximately 300 foremost manufacturers in the power engineering equipment field.

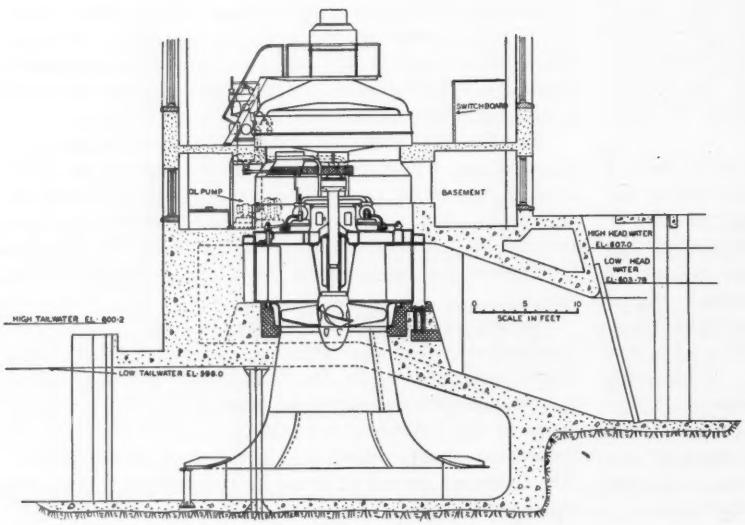
Hydroelectric System *of the city of K*

Rapide Croche Plant

Three hydroelectric power plants with a total generating capacity of 7900-kw. supply the municipal system of Kaukauna, Wis., with electric power. One of these, the Old Badger plant dating from about 1895, is used only as standby and the 1000 and 900-kw. General Electric 2200-v., 3 ph. 60 cycle generators driven by S. Morgan Smith horizontal wheels are used only when the new Badger plant is down.

Rapide Croche, completed about 5 yr. ago and located on the Fox River some distance below Kaukauna, is the second largest plant with a capacity of 2400-kw. in four units. It was designed by Wm. Kolb, at that time engineer of the Green Bay-Mississippi Canal Co., and consists of four Allis-Chalmers adjustable blade propeller turbines, operating under a head of 8 ft., and driving Allis-Chalmers 750-kv-a., 2400-v. 3 ph., 60 cycle generators with direct connected 20 kw., 125-v., d.c. exciters at 90 r.p.m.





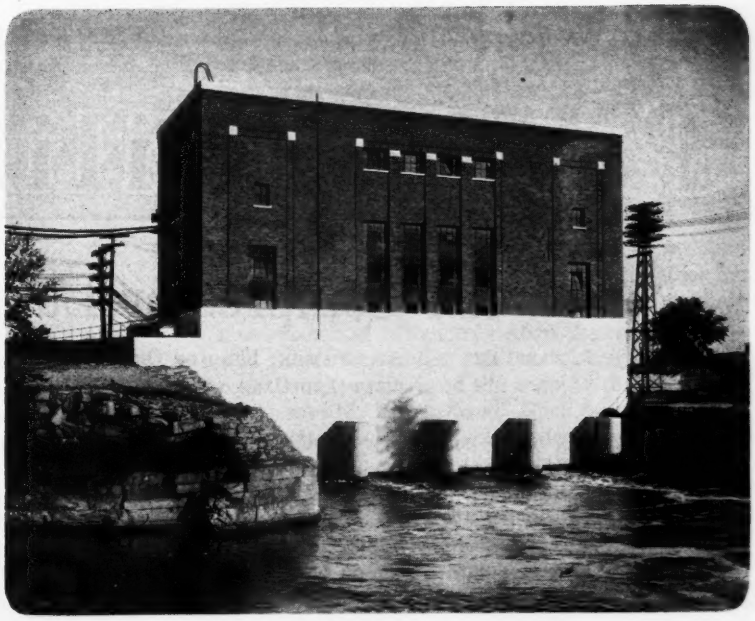
Entire equipment of the four main units was furnished by the Allis-Chalmers Manufacturing Co. and reports of the operating department of the City of Kaukauna show that these four units have operated over a period of 5 yr. without one cent being spent for repairs. The plant is tied in with the remainder of the system, through a bank of three 1000-kva. 2300/11,500-v. General Electric transformers, by an 11,500-v. transmission line. It is an automatic plant controlled by float switches.

Draft tubes used with these runners are of the Hydrocone type which require somewhat wider spacing than other designs but the depth of excavation is reduced. In actual power plant setting, test units developed 1100 hp. under an 8-ft. head and will deliver power at the synchronous speed at a head of as low as 3½ ft. The blades are adjusted from an operating mechanism located between the turbine and generating shaft and require that the unit be shut down for making adjustment.

One of the important features of this plant is the basement provided below the generator

Kaukauna, Wis.

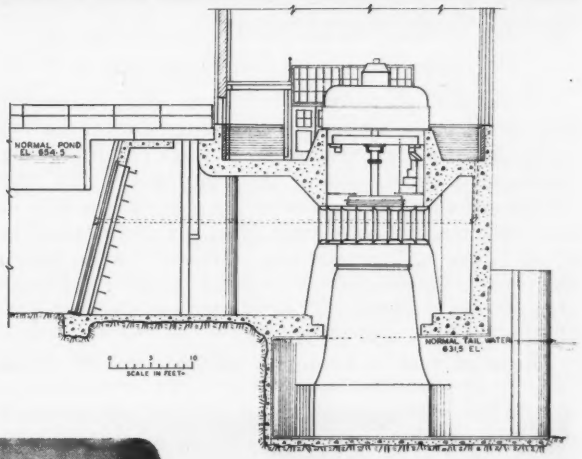
New Badger Plant

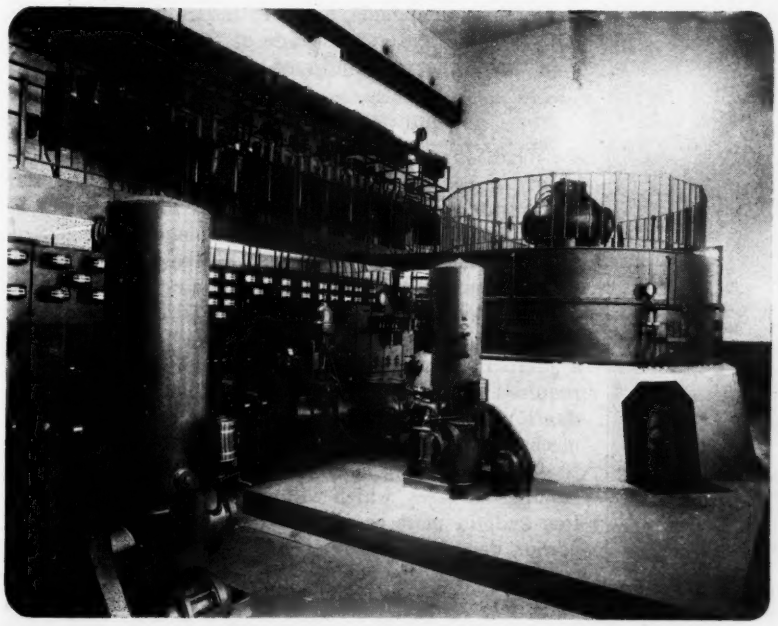


floor without added increase in height of the power plant substructure. This is well shown in the cross section of the plant. This basement space is valuable for the storage of oil and other supplies and in addition provides a work shop. Advantage of this over the single floor is obvious. Machines are more accessible for operation and dismantling purposes, the appearance of the station is improved because it is not necessary to have cables extending up to the generator room nor is it necessary to have supplies on the generator room floor.

General effect of the Rapide Croche plant is pleasing as only the generators and exciters are set on floor level. Machinery stands out alone in the power plant substructure and a view of the entire equipment can be obtained. The switchboard position is on the down stream side of the power house between the two middle units.

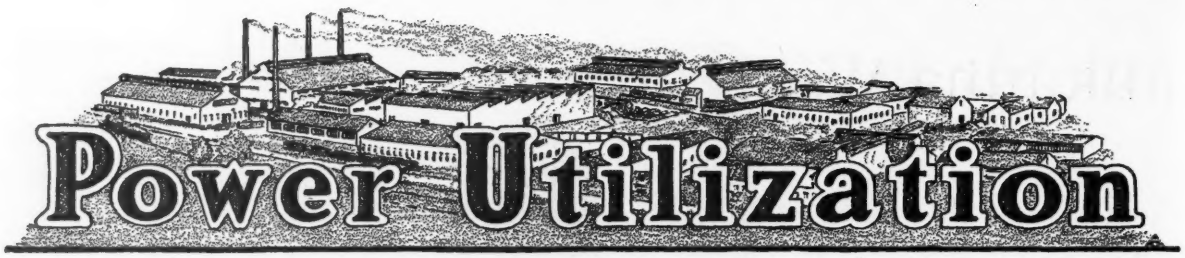
Oil pumps for the governors are driven by 7½-hp., 220-v., 570-r.p.m. Allis-Chalmers motors; cooling water, strained by Elliott strainers, for the bearings is supplied by two Dayton-Dowd 3-in., 100-g.p.m., 75-ft. head centrifugal pumps, driven at 715 r.p.m. by Allis-Chalmers 5-hp., 220-v. motors. Compressed air for brakes is supplied by a General Electric air compressor driven by a 220-v., 14-amp. motor. Power and lighting current is supplied by a bank of three 15-kv.a. 2300/220-v. transformers. The four units are served by a 20-t. Northern crane.





New Badger plant designed by Ralph D. Thomas, Consulting Engineer, Minneapolis, Minn., is the latest addition to the system. It is located in the city, adjacent to the old Badger Plant and has two S. Morgan Smith 2475-hp. propeller type wheels operating under a head of 24 ft. and driving General Electric 2400-v., 3-ph., 60-cycle generators at 150 r.p.m. Each unit has a direct connected 35-kw., 125-v. d.c. exciter and a Woodward governor. As shown in the photograph the 28 panel black slate General Electric switchboard is installed back of the generators with remote controlled solenoid operating switch on the balcony above. Control equipment is operated by a 60-cell Exide battery charged by a General Electric 1½-kw. battery charger set. Compressed air for the brakes is supplied by a 6½ by 8-in. Worthington compressor, close belted to a 10-hp., 220-v., 1800-r.p.m. General Electric motor.

All three plants were built and are owned by the Green Bay & Mississippi Canal Co., which holds all water rights on the Fox River. These plants are leased to the city for 20 yr.



Air Compressor Lubrication

APPLICATION, KIND OF OIL, METHODS OF HANDLING AND CARE OF OIL. BY H. L. KAUFFMAN

LUBRICATION of air compressors involves that for air cylinders and for steam cylinders, hence, two different grades of oil are required. In general, air-cylinder lubricants must be capable of standing the fairly high temperatures that exist by reason of the work done on the air during the compression stroke.

As for any type of machinery, one must consider the means or system of lubrication to be used when selecting the grade of lubricant to employ.

METHODS OF APPLYING LUBRICANT

Mechanical force-feed lubricators, Fig. 1, having positive oil feeds, are now in wide usage for lubricating the cylinder walls, the number of feeds required being dependent upon the size of the compressor. This type of lubricator can be regulated for a minimum rate of feed and, once adjusted, will force a uniform quantity of oil to the rubbing surfaces. Over-lubrication rather than under-lubrication is back of many compressor troubles and the force-feed lubricator minimizes the possibility that this will occur.

Each oil inlet to a cylinder should be fed by an individual oil pump, thereby permitting definite control for each feed. Should the lubrication system be so designed that one oil lead is branched to several inlets to a cylinder, the oil will naturally follow the path of least resistance and will flood some parts while others are inadequately lubricated.

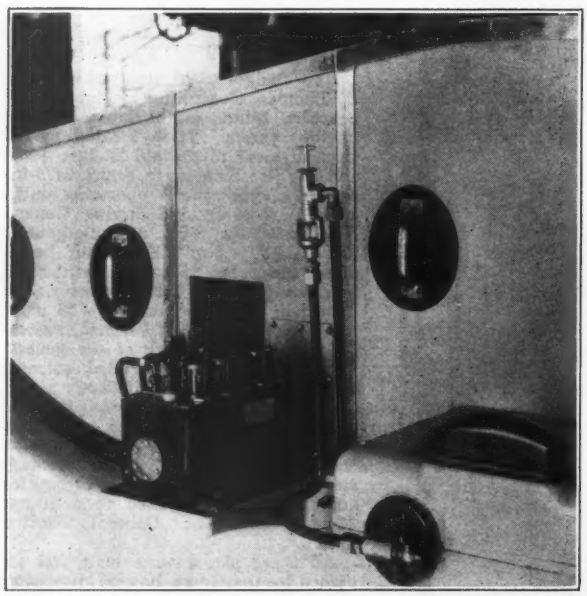


FIG. 1. McCORD FORCE FEED LUBRICATION ON COOPER AIR COMPRESSOR

Where single-acting trunk pistons are splash lubricated, it is important that a constant oil level be maintained in the crankcase. Here's why:

Too high an oil level will produce too much splash so that an excessive amount of oil will work past the piston rings. Result: carbonization of the oil under the excessive heat of compression; further, the accumulation of carbon on the discharge valves will cause them to stick, especially if the air is dirty. On the other hand, if the oil level in the crankcase is too low, the splash will be insufficient and some of the wearing surfaces will receive too little lubrication.

As to cylinder valves, plate valves and leather disc valves require no lubrication; flap valves need lubrication only at the hinges; Poppet valves and valve stems are generally lubricated sufficiently by the oil mist which is mechanically entrained in the air. Corliss valves must be lubricated on all rubbing surfaces, particularly at their ends, hence cylinders fitted with Corliss valves will use an average of 50 per cent more oil than those otherwise equipped.

REQUIREMENTS OF COMPRESSOR OIL

What is needed in a compressor oil? First of all, an oil of the *correct viscosity* or body for your particular compressor. When the compressor is new, you will be guided by the manufacturer's recommendations. Thereafter, as the surfaces wear, you will likely require an oil slightly heavier in body than that at first employed.

How shall you know whether the oil is too viscous or too light? When too thin an oil is employed, you'll see a jump in your oil consumption; for more oil will be required to maintain the necessary oil film; and, if you *don't* use that additional amount of oil, look out for mechanical troubles.

Oil too heavy in body will spread too slowly over the rubbing surfaces, which will result in excessive friction loss and, in most cases, will form a larger amount of carbon deposit than for oil of the proper viscosity.

Personally, the writer believes that flash and fire tests have been over-emphasized in giving consideration

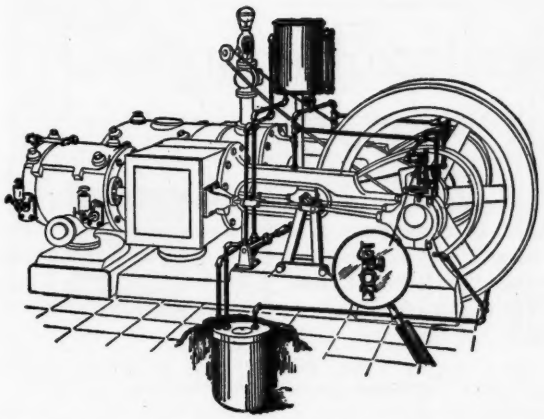


FIG. 2. TYPICAL OIL CIRCULATION FOR AIR COMPRESSOR BY VACUUM OIL CO.

to oils for air-cylinder lubrication. Most assuredly you want an oil that will stand up as long as possible under operating conditions; but a higher flash test on an oil doesn't necessarily mean that it's the better oil.

From the standpoint of oil consumption, the writer believes that an evaporation test is a better criterion as to the relative merits of two oils than a comparison of the flash tests. Better yet but more complicated, due to the laboratory apparatus required, is a vacuum distillation of the oil samples being compared to see which contains the lessor percentage of low-boiling constituents; it has been shown that the oil with the smaller percentage will better withstand the high temperature conditions and with a less consumption of lubricant.

Because the flash point of an oil is only 360 deg. F., that oil will not necessarily be a greater safeguard against an air-compressor explosion than would an oil with a 400-deg. flash point. Air-compressor explosions are caused by bad operating conditions, as a consequence of which cylinder temperatures get so high that any lubricating oil will vaporize and decompose. When this happens, an explosive mixture is formed and then—look out! But the lower flash point oil will not necessarily contain the greater percentage of low volatile hydrocarbons. You'll get more accurate knowledge of this from either an evaporation or a vacuum distillation test. For use in specifications, 360 deg. F. as a minimum flash point is suggested.

In selecting an air-cylinder lubricant, other qualities being equal, give preference to the oil with the lower Conradson carbon residue content. When an oil breaks down, it first becomes sticky and gummy so that dirt brought in by the air adheres; then we soon have the "carbon deposit" with which all operators are familiar. Excessive carbon formations not only are a nuisance but affect the efficiency of the compressor and are hazardous.

In a number of instances, carbon deposits have collected in the valve passages and bends of piping to such a degree that they restricted the opening through which the compressed air had to pass. Such formations, once started, continue to build up and so decrease the passageway that pressures may be built up capable eventually of causing an explosion. Remember, too, that carbon is a poor conductor, hence is subject to being heated considerably above the temperature of the cylinder walls. In this way, it may be partly instrumental in an explosion.

TABLE I. OIL REQUIRED FOR AIR-CYLINDER LUBRICATION

Cylinder Diameter	Piston Displacement	Rubbing Surface Sq. Ft.	Oil Feed	
			Drops per Minute	Pints per 10 Hours
Up to 6"	Up to 65	Up to 500	1	.05
6" to 8"	65-125	500-750	1	.08
8" to 10"	125-225	750-1100	1	.11
10" to 12"	225-350	1100-1500	1-2	.14
12" to 15"	350-600	1500-2000	2-3	.20
15" to 18"	600-1000	2000-2600	3-4	.27
18" to 24"	1000-1800	2600-3600	4-5	.36
24" to 30"	1800-3000	3600-4800	5-6	.48
30" to 36"	3000-4500	4800-6000	6-8	.60
36" to 42"	4500-6500	6000-7500	8-10	.74
42" to 48"	6500-9000	7500-9000	10-12	.90

1. The foregoing figures are for one cylinder only; for duplex or compound machines, both cylinders must be considered.
2. Cylinders with Corliss valves will use about 50 per cent more oil than is given in the foregoing table.

How Much Oil to Use

Use only enough oil to keep the cylinder walls and valves just greasy, neither dry nor wet. As a guide to show approximately the amount of air cylinder oil required for good lubrication, the Compressed Air Society has prepared a table that shows the drops per minute for different sizes of air cylinders, also the maximum quantity in pints per ten hours that should be used:

Steam Cylinder Lubrication

What steam cylinder oil to use is influenced by steam conditions, such as pressure, wetness or dryness of the steam, whether any boiler compound is carried by the steam into the cylinder.

For steam cylinders, the proper quantity of oil to be fed is much greater than for air cylinders, due to constant washing away of the oil by the steam. Approximately four times as much oil is required for the steam cylinders as for the air cylinders, although local conditions may change this ratio somewhat.

According to the Compressed Air Society, a pint of steam cylinder oil will furnish, depending upon its viscosity, from 5000 to 8000 drops; taking an average of about 6500 drops, and four times as much oil as for air cylinders of the same size, and working at the same piston speeds as given in the table, the recommended

TABLE II. OIL FOR STEAM CYLINDER LUBRICATION

No. Drops Per Minute	Size of Cylinder Inches	Number Pints Oil Required per 10 Hours
4	8x8	.4
8	12x12	.75
16	18x18	1.5
24	24x24	2.25
32	30x30	3.0
40	36x36	3.75
48	42x42	4.5

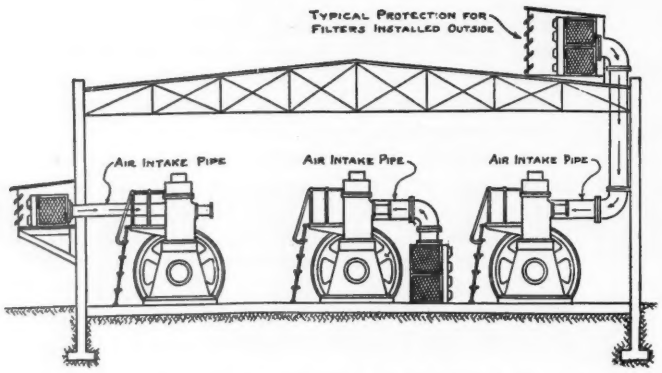


FIG. 3. THREE ARRANGEMENTS OF AIR FILTER BY REED AIR FILTER CO.

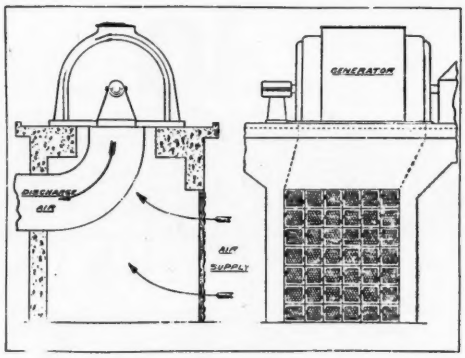


FIG. 4. AIR FILTER FOR ELECTRIC GENERATOR BY SPRAY ENGINEERING CO.

amounts to feed the steam cylinders or their equivalents are as follows:

Cleanliness of the air taken into an air compressor has a definite relation to the extent of the carbonization of the oil. The more contaminated the air, the greater the accumulation of deposits in the passageways, which in turn leads to abnormal temperatures by reason of the greater frictional resistance.

Analysis of many carbon deposits from air compressors showed that these deposits contain more dirt than pure carbon, the whole being bound together by sticky, gummy matter from decomposed oil.

Figure 3 shows various ways in which an air filter can be installed, according to the location of the air intake. Figures 4 and 5 show different designs in use.

Modern air filters work on the principle of the human nostril, in that by suitable arrangement of the filtering media and certain baffles, the passage of foreign matter is arrested while the air can pass through freely. It must be borne in mind, however, that an air filter should be cleaned at regular intervals, varying from one to three months; for in time the filter becomes clogged and, unless cleaned, will not function effectively.

To clean a metallic filter, place it in a vat filled with a hot soda solution. Such a solution cuts dust, grease and oil; hence, by dipping and sluicing the filter cells therein, the filtering media can be brought back to condition, the pores cleaned and the entire unit made fit once again for developing maximum efficiency. When the metallic filters are to be coated with oil or any other dust-absorbing fluid, they should be re-dipped in such a medium after cleaning, then allowed to drain of any excess oil, before replacement in the filter bank. Felt vane filters can be cleaned in place, by blowing air through in reverse direction.

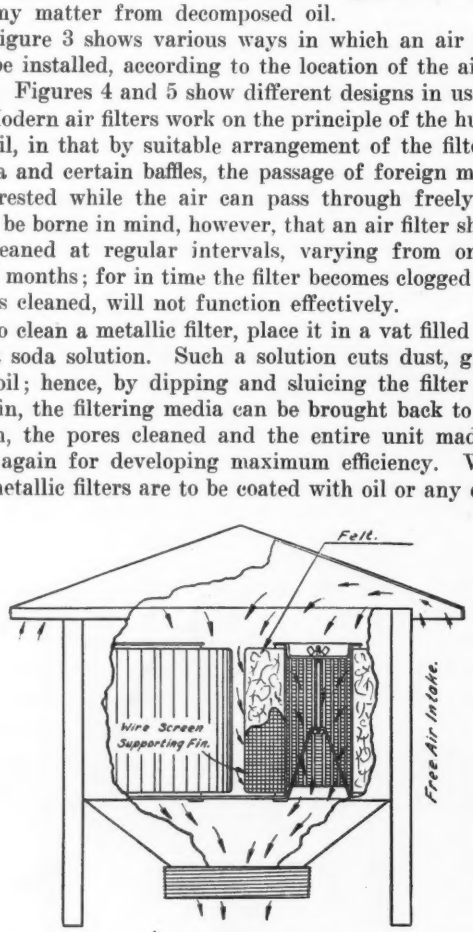


FIG. 5. COMPRESSOR INTAKE AIR FILTER OF STAYNEW FILTER CORP.

This Matter of Explosion

It is generally conceded that air-receiver and air-line explosions are caused by the ignition of explosive mixtures of air and hydrocarbon vapors from the lubricating oil. What precautions should be taken to minimize such occurrences?

First, use no more oil than is actually necessary to lubricate the wearing surfaces.

Second, give heed to slight initial explosions that do no damage but which are an automatic signal to the operator that it is time to clean out the compressor passageways and the oil and water accumulations in the receiver. When an air line starts to fill up with a gummy deposit, which is generally at some point of natural obstruction, the restricted passage forms a trap and allows the collection of the vapors and oil. When conditions are right, an explosion or a series of explosions of non-violent nature then takes place. Although such explosions can be dissipated along the pipe lines and cause no material damage at the time, the heat of each explosion bakes the deposit hard and finally overheats the pipe so that eventually it ruptures.

Third, guard against the formation of pockets and traps in the air lines.

Fourth, if the air receiver is not designed for the constant scavenging of the tank and thus minimizing explosions by preventing the accumulation of oil vapor and vapor mixtures, then make it a practice to drain the water and oil from the bottom of the receiver each day and clean the unit regularly.

Safety valves, as such, come into action after an explosion has taken place: they do not prevent the formation of volatile vapors that cause the explosion. When the amount of vapor is slight or conditions are not just right for a serious explosion, the usual safety valve will release the pressure and thereby prevent the building up of heat that would bring the heavier hydrocarbon vapors into action. When conditions are just right for a violent explosion, any number of safety valves will not prevent it. Safety valves prevent some explosions but, as they can not and do not prevent all explosions, they must be considered only a partial remedy.

Checks on Rotating Electrical Apparatus

PERIODICAL TESTS NEEDED TO ENSURE CONTINUOUS OPERATION. BY A. C. ROE*

TO INSURE continuous operation of rotating electrical apparatus of all types, it is necessary to make periodical tests to check the condition of the various parts of a motor or generator, and it is time well spent to isolate different sections at stated intervals, so that their condition can be determined and recorded, and repairs made before serious trouble occurs.

Numerous troubles may develop during operation, that reduce the efficiency and in time cause shutdowns for minor or extensive repairs and it is the purpose of this article to discuss briefly the various items that should be checked. Later articles will give methods of testing to detect the conditions enumerated.

Rotating electrical apparatus troubles can be divided into groups as, mechanical, commutation, dielectric, electrical, ventilation, cleanliness and, while some groups are inter-related, we can discuss the items under each heading.

MECHANICAL TESTS

Check air gaps at four points, at least, for bearing wear, recording findings in thousandths of an inch to indicate rate of wear and condition of air gap, out of round, or worn bearings. Check parallelism of pole pieces and their tightness. Check coil or end winding bracing for looseness; check for loose retaining bands on armature; check end play, condition of shaft in bearings for indications of shaft circulating currents; check oil rings for proper running.

When changing oil that has been in a bearing for some time, it is well to check for shaft currents when new oil is installed; this applies to motor-generator sets with uninsulated bed plates. It may seem peculiar advice but, in one case of which I know, the alternating-current end of a direct-current generator, synchronous motor set was rewound and the oil in the three pedestal bearings changed. One year after rewinding and in a short time after changing oil, a bearing burned out and a second one was nearly lost before the trouble was traced to shaft currents. Insulating the pedestals cured the trouble. This indicates how troubles can develop from the least expected sources after a combination of changes.

Check armature for end play and floating magnetic center.

INSULATION TESTS

Under the heading, commutation, comes, brush spring pressure, high bars or mica, poorly soldered joints, sticking or loose brushes, out of round commutator, flat spots, brushes out of line with bars, brushes off neutral or unequal spacing of brush holders. All these can be detected by a visual inspection, before trouble develops.

Tests should be made of the condition of insulation as a protection against grounds or shorts between phases. There has been considerable discussion regarding the advisability of subjecting equipment to periodical high-voltage tests; there is also a wide range of opinion as to what the voltage for such tests should be. The A.I.E.E. rules govern new apparatus and the following suggestions are based on these standard A.I.E.E. rules:

(1) Partially rewound or repaired machines.

Synchronous converters and all direct-current machines, 60 per cent of present A.I.E.E. tests.

All alternating-current machines 75 per cent of present A.I.E.E. tests.

(2) Maintenance tests on apparatus thoroughly cleaned and inspected at regular intervals.

Synchronous converters and direct-current machines 50 per cent of present A.I.E.E. tests.

All alternating-current machines including the direct-current fields, 60 per cent of present A.I.E.E. tests for each section of the material.

Before applying a high voltage test, a megger can be used to check the condition of the machine or megger readings can be taken at regular intervals and the records used as an indication of the condition of the apparatus and a guide for cleaning, repairing, or rewinding.

When an air-drying varnish is used as a protecting coat after cleaning or repairing, it should be allowed to dry thoroughly before taking megger readings or applying a high-voltage test, nor should these tests be made while the machine is hot. After painting with air-drying varnish, the tests should be deferred until the machine has cooled after a load run of sufficient duration to bring it up to normal operating temperature.

ELECTRICAL TESTS

Under this heading are included copper losses, core losses, power factor, efficiency, surges, low voltage, high voltage, overload; and one positive check on the correct operating conditions of any type of motor is, to have an ammeter in the motor circuit at all times. Readings taken and recorded at regular intervals and for various load conditions, will give indications of ageing iron, high magnetizing current, unbalanced phases and the like.

Electrical characteristics or performance of the major units should be checked to determine how they compare with modern equipment and, if the difference is great, a study should be made to find the cause. If the apparatus is of old design, the original manufacturer should be consulted. The reason for the preceding statement is based on the fact that a large number of old machines have been rebuilt at a nominal cost, with higher ratings, reduced losses, improved power factor, by using modern engineering skill, materials and processes. Subsequent articles will describe methods of testing electrical apparatus for copper losses, efficiency, core losses, temperature and other conditions.

This is an important item in any rotating electrical apparatus, as it is the medium by which heat is carried

*Westinghouse Electric & Mfg. Co.

away from the windings and operating temperatures kept to safe values.

All air ducts should be checked and kept clear. The air entering the apparatus should be tested for the presence of harmful ingredients, such as iron dust, moisture and acid fumes; if air is taken from outside, the surrounding terrain should be examined for mineral matter.

A case of trouble on a number of large high-voltage generators and the cause is the reason for the above statement, as the generators in question were provided with forced ventilation and the air taken from the outside. Breakdowns to ground occurred periodically and poor insulation was claimed. After careful study of all factors, an engineer found that iron ore was present in large quantities and the air forced into the windings was carrying the ore, which, when deposited on the windings caused the trouble. A filtering system cured it.

Cleanliness of windings is good insurance against breakdowns and fire and all equipment should be inspected at regular intervals to prevent the accumulation of dirt, dust and grease.

No attempt has been made in this short article to give details of tests, but the major factors that affect operation have been cited so that they can be checked. In later articles some methods of making detailed tests will be given.

Factors Involved in the Selection of Pumps

Types for Various Services, Speeds, Methods of Driving, Power Required

SO THAT A pump may give the best service as to reliability, economy of operation and minimum of labor for care and upkeep, care should be given to its selection to fit the service conditions.

Factors involved in the choice are head against which the pump must operate, capacity required, speed of running, drive available, power required, nature of load and cost of pump. First cost should come last, since satisfactory performance is always more important than first cost.

As between reciprocating and centrifugal pumps, decision will be governed largely by the kind of service, speed of operation and the drive which it is desired to use. Reciprocating pumps will be better to handle heavy, viscous liquids, small quantities at high heads and liquids containing gritty material. They are essentially slow speed machines and give, of course, intermittent flow. Centrifugal pumps are adapted for direct connection to high-speed drivers, for large quantities of liquid at low or moderate head and steady flow. They are light weight and inexpensive but for high suction lift are less satisfactory than the reciprocating type.

By the use of belting or gears, either type may be driven from any speed of driver. The reciprocating pump should run at not over 100 r.p.m., hence requires considerable speed reduction, if driven from a high-speed motor or steam turbine. On the other hand, the centrifugal pump requires considerable speed multiplication if driven from a Diesel or steam engine.

Reciprocating Pumps

In the reciprocating pump, capacity varies as the speed and any head can be pumped against, regardless of speed, up to the point of stalling the driver. As the pump starts under full load, high starting power is needed, hence, for Diesel engine drive, it is desirable to have a clutch or a bypass from discharge to suction, to reduce starting torque. For motor drive, a direct-current motor is used of compound-wound type or a slip-ring alternating-current motor for large pumps. No bypass is required. For small size pumps a bypass will permit use of shunt-wound or squirrel-cage motors. If a synchronous motor is used, it must be of a design to have large starting and pull-in torque or it will stall frequently.

Where steady flow is essential, especially if a pump is to be run at slow speed so that discharge will pulsate, the use of a storage accumulator or of an air chamber on the discharge line near the pump will be helpful.

Since the head on the pump will rise with resistance in the discharge line, up to the point where the driver is stalled, it is desirable to provide a relief valve on the line near the pump outlet, to avoid overstrain in case the pump should be started with all outlets from the discharge line closed.

Centrifugal Pumps

With centrifugal pumps, since the force to overcome head is proportional to the speed, the discharge will vary with the speed and the head pumped against but, at a given speed, head above a certain value will not be overcome, regardless of the discharge called for. If head is too great for the pump speed, closing the discharge valve will have no effect, as the impeller simply churns the liquid in the casing, hence no relief valve is required.

For a constant speed, at 125 per cent of the normal head, discharge will be zero while, if head drops to 75 per cent of normal, discharge will be 120 per cent of normal. On the other hand, if speed be varied to suit the head, at 20 per cent of normal head discharge will be zero; at 75 per cent head, discharge will be 87 per cent normal; at 125 per cent head, discharge will be 110 per cent.

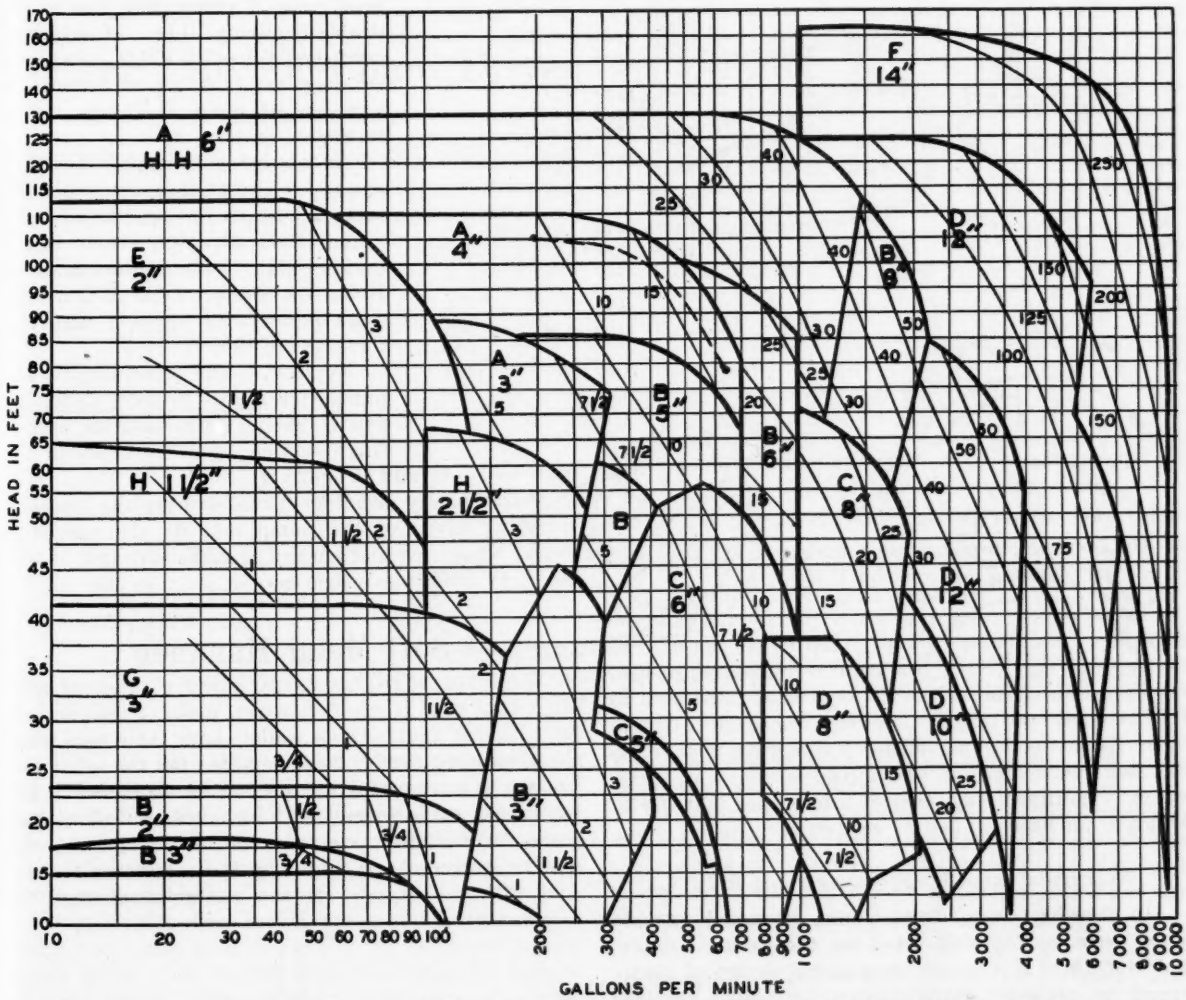
Because of its characteristics, a centrifugal pump must be of a design suited to the service required of it. Impeller and casing should be fitted to the head and character of the liquid to be handled in order to get good efficiency, and, if varying discharge is required, a variable speed drive should be provided. In general, efficiency will be better for high capacity and moderate or low head than for the reverse. Up to 300 gal. per min., the reciprocating pump is usually the more efficient.

Driving Power Required

In determining the power to be installed to drive a centrifugal pump, it must be remembered that for constant speed, as head pumped against falls off, velocity

of flow increases, the discharge increases as the square of the velocity and power required increases as the cube of the velocity, but decreases only as the first power of the head. A drive which may be ample at normal head may, therefore, be inadequate, if head resistance is lowered 20 per cent.

Power needed is fixed by the total head resistance and the weight of liquid handled. Head resistance is made up of four parts, suction lift, static discharge and multiplied by a condition factor based on tests. As the calculation is somewhat tedious, friction head per 100 ft. of pipe for clean water at various rates of flow have been prepared in tabular form by Goulds Pumps, Inc., an abstract of the table being given herewith. Tabular values given are for iron pipe 15 yr. old. For new, smooth brass pipe these should be multiplied by 0.6 for new iron pipe, by 0.7; for iron pipe 25 yr. old by 1.2.



CENTRIFUGAL PUMP SELECTION CHART, 1150 R.P.M., SHOWS SUITABLE TYPE, SIZE AND POWER FOR DRIVING

head, velocity head at the outlet and friction head. The first is the lift in feet. The liquid may come to the suction under pressure, in which case the lift is negative and is the pressure in pounds per square inch times 2.31 divided by specific gravity of the liquid.

Discharge head is the lift in feet, or pressure in pounds per square inch times 2.31 divided by specific gravity of the liquid. Velocity head is that required to set up the velocity at discharge and is velocity in feet per second squared, divided by 64.4. Friction head depends on the velocity through the pipes, length and diameter of pipes, and the condition of surfaces. Its value is the ratio of length to diameter (both taken in feet or inches) times velocity squared, divided by 64.4

Friction is increased by elbows and fittings, their resistance being usually expressed in equivalent length of straight pipe and values for 90 deg. elbows being as follows:

STRAIGHT PIPE EQUIVALENT OF 90-DEG. ELBOW, FT.

Size Pipe, in.....	¼	½	¾	1	1½	2½	3	4	6	8	10
Pipe, Equiv. ft.....	3	5	6	6	8	11	15	16	18	24	30

For liquids other than water, friction depends on the viscosity and should be determined by test data from similar installations.

Having the total head, the horsepower required to move the liquid is:

FRICTION HEAD LOSS FOR WATER IN IRON PIPE 15 YR. OLD, FEET HEAD LOST PER 100 FT. OF PIPE

Flow Gal. per Min.	Nominal Pipe Diameter, in. ¼	½	¾	1	1½	2	2½	3	4	6	8	10
1	28	2.1	...	....	....	....	....	....	....	....	....	....
2	103	7.4	1.9	....	....	....	....	....	....	....	....	....
3	...	15.8	4.1	1.26	....	....	....	....	....	....	....	....
4	...	27.0	7.0	2.14	0.26	....	....	....	....	....	....	....
5	...	41.0	10.5	3.25	0.40	....	....	....	....	....	....	....
10	...	147.0	38.0	11.70	1.43	0.56	0.17	0.07	....	....	....	....
15	...	.....	80.0	25.00	3.00	1.08	0.36	0.15	....	....	....	....
20	...	.....	136.0	42.00	5.20	1.82	0.61	0.25	....	....	....	....
30	...	.....	.....	89.00	11.00	3.84	1.29	0.54	....	....	....	....
40	...	.....	.....	152.00	18.80	6.60	2.20	0.91	0.22	....	....	....
50	...	.....	.....	.....	53.00	18.40	6.20	2.57	0.63	....	....	....
75	...	.....	.....	.....	60.00	20.90	7.10	3.00	0.73	....	....	....
100	...	.....	.....	.....	102.00	35.80	12.00	4.96	1.22	0.17	....	....
125	...	.....	.....	.....	.....	54.00	18.20	7.60	1.86	0.27	....	....
150	...	.....	.....	.....	.....	76.00	25.50	10.50	2.62	0.36	....	....
175	...	.....	.....	.....	.....	102.00	33.80	14.00	3.44	0.48	....	....
200	...	.....	.....	.....	.....	129.00	43.10	17.80	4.40	0.62	....	....
225	...	.....	.....	.....	.....	.....	54.30	22.30	5.45	0.77	....	....
250	...	.....	.....	.....	.....	.....	66.00	27.20	6.72	0.95	0.23	....
275	...	.....	.....	.....	.....	.....	.....	32.50	8.05	1.12	0.27	....
300	...	.....	.....	.....	.....	.....	.....	38.00	9.30	1.32	0.32	....
350	...	.....	.....	.....	.....	.....	.....	.....	12.40	1.75	0.42	....
400	...	.....	.....	.....	.....	.....	.....	.....	16.00	2.21	0.55	....
450	...	.....	.....	.....	.....	.....	.....	.....	19.80	2.37	0.69	0.23
500	...	.....	.....	.....	.....	.....	.....	.....	24.00	3.34	0.83	0.28
600	...	.....	.....	.....	.....	.....	.....	.....	.....	4.91	1.16	0.40
750	...	.....	.....	.....	.....	.....	.....	.....	.....	7.12	1.77	0.60

Hp. = Head in ft., times gallons per min., times specific gravity, divided by 3960;

or for water whose specific gravity is 1,

Hp. = Head pressure in pounds per sq. in., times gal. per min., divided by 1715.

These power values to move the liquid must be divided by the efficiency of the pump to get power to be delivered by the driver. For small reciprocating pumps, efficiency runs from 0.37 at 20 per cent of rated head to 0.75 at rated head; for large pumps the range is 0.52 to 0.85. Centrifugal pump efficiency runs from 0.50 at 100 gal. per min. to 0.70 at 1000 g.p.m. and 0.72 at 10,000 g.p.m. Additional allowance of 5 to 10 per cent should be made for losses in belt or gear drive

Selection Charts for Centrifugal Pumps

In choosing a centrifugal pump, often two or more types seem equally well fitted for the work. Usually, however, there is a determining factor, design of pump, speed or capacity characteristics or power required which should decide the choice. It is well to consult with pump manufacturers for their suggestions, giving full details as to the service required of the pump and asking for characteristic curves and prices. Comparison can then be made of various types and makes as to power, performance under variable load conditions and costs of installation and operation.

To aid in such selection, a series of charts such as those prepared by Goulds Pumps, Inc., one of which is shown herewith is helpful. It gives for any head and capacity the type and size of pump recommended and the driving power required, indicated on the light lines. The chart shown is for 1150 r.p.m., a speed suitable for direct connection to 60-cycle a.c. motors, d.c. motors or gas engines and for belt or gear drive. Other standard speeds are 1450, 1750, 2850 and 3450 r.p.m., a separate chart being prepared for each speed. If service required falls between curves for horsepower, it is better to use the next larger motor or to draw through the located point a curve parallel to the heavy black line next above, as it may turn out that an even larger motor is required, if head is variable. For instance, if 200 g.p.m. are to be handled at 105 ft. head, type A pump, 4-in. size is desirable requiring 10 hp. If, however, head should drop to 100 ft., the pump running at 1150 r.p.m., discharge would be 400 g.p.m. and 15 hp. would be needed to drive it.

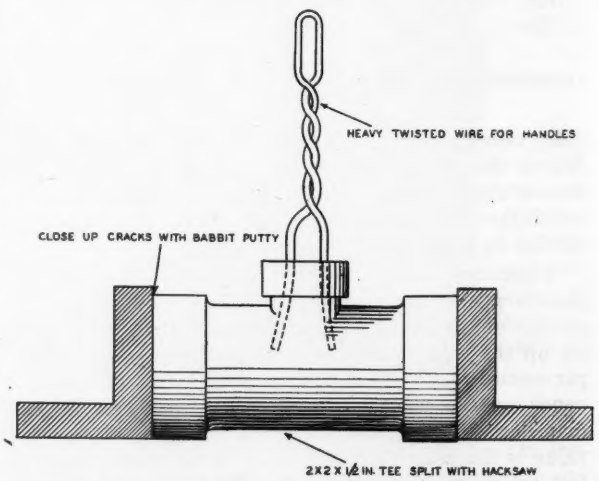
As an index to types, A, B, C and D refer to single-stage double-suction pumps for speeds to 2850 r.p.m. A is for high heads, B for medium high, C for medium low and D for low heads. Type E is a two-stage pump with opposed impellers for heads to 1000 ft.

Types F, G and H are single-stage pumps for speeds to 3450 r.p.m. F and H having double suction and G single suction. F is for heads to 250 ft., G to 375 ft. and H to 625 ft.

Before finally deciding, curves showing the complete operating range of the pump and its characteristics should be secured and studied to make sure that it will meet any conditions which may arise in service.

Soft Metal Hammer

Employes in engine rooms, power plants and mills often have need of a soft hammer, made of lead or babbit. Rubber and rawhide mallets have their uses when electrical machinery is being repaired but the soft metal hammer is more useful when repairing machinery. The writer has made several soft hammers as follows and passes on this information for the benefit of those who may be interested. A 2 by 2 by ½-in. cast-iron tee was split with a hack saw, the saw cut going through the



METHODS OF CASTING SOFT HAMMER

centers of all three openings. When this mold was to be used, the halves were wired together and placed with the half-inch opening upward, the 2-in. openings being closed by smooth iron blocks placed against the ends: A ½-in. rod was inserted in the ½-in. hole and the hot metal poured alongside the rod. Babbit putty was used to close up the small cracks around the 2-in. openings to prevent the escape of hot metal. Hammers of this kind were made up with both babbit and lead. A heavy wire, doubled and twisted, also makes a good handle.

Cold Spring, Minn. CHAS. A. PETERSON.

Longer Life for Chain Drives

BY CHARLES R. WEISS*

RECENTLY, I was asked, "How Can I Make Chain Drives Last Longer?" After considering the question, I answered this maintenance man as follows:

There are just 5 simple things for you to do, illustrated by these sketches.

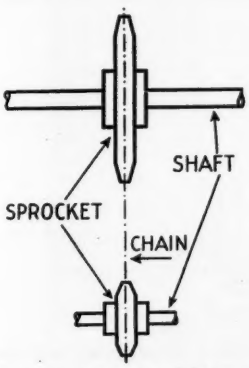


FIG. 1. KEEP SPROCKETS AND SHAFTS ALINED

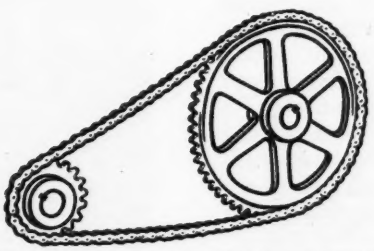


FIG. 2. HAVE THE CHAIN A LITTLE SLACK

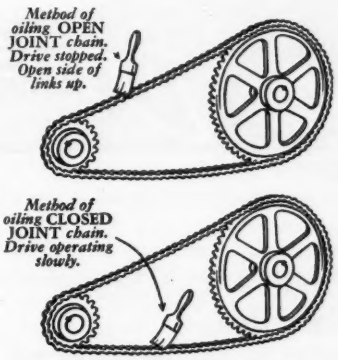

Method of oiling OPEN JOINT chain. Drive stopped. Open side of links up.
Method of oiling CLOSED JOINT chain. Drive operating slowly.

FIG. 3. LUBRICATE CHAIN FREQUENTLY

FIG. 4. CLEAN CHAINS OFTEN

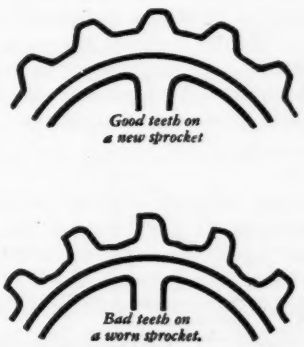


FIG. 5. REPLACE WORN SPROCKETS

First. Be sure that sprocket wheels are in line on the shafts, as shown in Fig. 1. If the sprockets are not exactly in line, a side pull develops which concentrates the load on the side of the sprocket teeth, and on one side of the chain. This results in excessive wear on both chains and sprockets.

Second. The chain should be run just a little slacker than a belt, about as shown in Fig. 2. Too much tension causes undue wear on the chain, and wasteful friction on the bearings. Not enough tension may, of course, allow the chain to jump the sprockets, or ride the teeth and break.

Third. Chains should be lubricated at frequent intervals. A good grade of light cylinder oil should be used. A paint brush is a good thing for applying oil to the chain joints, as indicated in Fig. 3. Paint the open joints on open (upper) side. Oil the closed joint chains on inside (upper side of lower run) while drive is running slowly.

Fourth. Open drives should be cleaned regularly. Take the chain off and clean it well by soaking and dipping in kerosene, see Fig. 4. Dry well, and oil it thoroughly before starting up again. Before shutting down a machine for a period of time, clean the chain, and oil it with heavier oil or grease. When it is to be used again, re-clean and oil with light oil.

Fifth. Last, but not least, examine sprocket wheels from time to time. Before the teeth are worn to a hook shape, as shown in lower illustration of Fig. 5, the wheels should be replaced with accurately made and close-fitting sprocket wheels.

By giving this attention to your chain drives you will make them last longer and run better, also reduce the chances of a breakdown. You will be time and money ahead and will get the best wear and service out of your machinery.

*Chief Engineer, Link-Belt Co., Indianapolis, Ind.

E. M. GILBERT, who has been vice-president and chief engineer of W. S. Barstow & Co., was elected president of that organization at a recent meeting of the board of directors. Mr. Gilbert received his technical training at Cornell University and then joined the American Stoker Co. of Dayton, Ohio. In 1899 he was sent abroad to install stokers in England and France, remaining there until 1907. After his return to the United States, he became chief engineer of the Leadville (Col.) Light & Power Co. In 1916 he became general manager of the Metropolitan Edison Co. and chief engineer of the properties of General Gas & Electric Corp.

ENGINES BUILT to run on natural gas deliver a brake horsepower at full load on from 9 to 11 cu. ft. of gas.

Overcoming Trouble With Stoker Pusher Rods

REFERRING to page 589 of the May issue, I have had some trouble in years gone by with pusher rods on underfeed stokers and will pass these comments on to the craft as they may help someone else and save him a lot of grief and experimenting.

Figure 1 shows the arrangement as originally installed. As designated, the end of the pusher rod was held down by a pusher rod guide, Fig. 2, and the end next to steam cylinder was connected to the crosshead

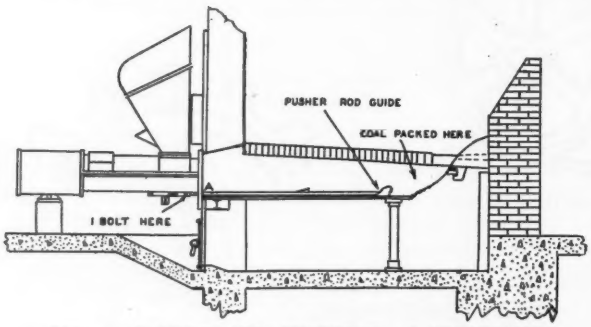


FIG. 1. STOKER ARRANGEMENT AS ORIGINALLY INSTALLED

links with one ¾-in. bolt. This worked fine for a time but the coal packed and baked so hard in the rear end of the retort that the end of the pusher rod extending through the guide turned up and broke off and the rod finally lifted up so high that it jammed in the pusher rod gland at A, Fig. 1, stalling the whole works. The mate to this stoker had a long pusher rod running the full length of the retort and out through a hole in the rear end of the retort. This rod buckled up in the middle and burned in two.

Therefore, we made a rod, as shown in Fig. 3, that seems to have solved our troubles. This rod, which is cut 5 ft. 9 in. long, is made of 1½-in. cold rolled iron. On the end that bolts to the crosshead it is shaped flat on each side leaving the rod 1¼ in. thick for a distance of 6 in. Two ⅞-in. holes are drilled in 3½ in. centers and the pusher rod and crosshead links bolted solid together instead of having a hinge effect as originally.

Pusher block No. 1, Fig. 3, is set 34 in. from center of hole nearest the boiler front and block No. 2, 26 in. from center of block No. 1. By center of block is meant the location of the set screws that hold the pusher block to the rod. These rods are run until they wear flat on the bottom between A and C, Fig. 3. Since starting to use this kind, about 10 yr. ago, only twice have we had pusher rods bend up on the rear end, but as the rods and crosshead links are all bolted solid together and could

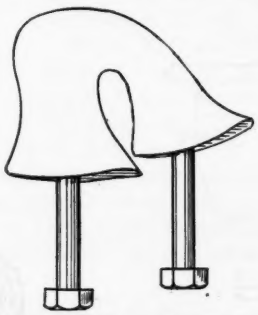


FIG. 2. PUSHER ROD GUIDE WHICH WAS REMOVED IN FINAL ARRANGEMENT

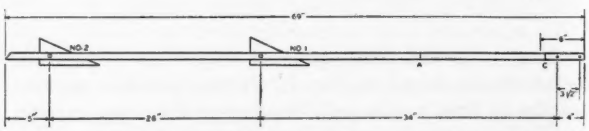


FIG. 3. PUSHER ROD NOW USED IN STOKER HAVING A 9-IN. RAM

not buckle outside of the retort, enough coal was worked back on the retort to protect it and the tuyere blocks and a shutdown was thus avoided until it was convenient to stop the stoker and make repairs. When this kind of rod is put in, the pusher rod guide, Fig. 2, is taken out altogether.

Minneapolis, Minn. FRED S. RUTLEDGE.

How to Locate Faulty Fuses on Three-Phase Motors

WHILE SERVING three-phase motors in our locality, we had considerable difficulty in locating blown fuses on three-phase motors. The fuses on any of these motors are alive only when the switch on the compensator is in the running position; consequently it is not convenient to test the fuses with the test light when the motor is not running. If the fuses are tested by a lamp when the motor is running single phase, it is difficult to locate a blown fuse, due to the fact that the voltage is

kept nearly normal on the motor side of the blown fuse by the generator action of the motor.

Under these conditions, I find it best to shunt each fuse momentarily with a short piece of insulated wire, instead of testing from the end of one fuse to the end of another. When a blown fuse is shunted by means of a wire, a spark will indicate that the fuse is blown and the absence of a spark will indicate that the fuse is a good one.

Hobart, Ind. HARRY J. ACHEE.

Power Pole Installation on Rock Surface

ACCOMPANYING illustration showing method of anchoring a power pole on a rock surface needs but little explanation.

This method is used by the Ontario Hydro Electric System in northern Ontario. The castings are bolted to

POLE CLAMPED IN RIGID POSITION ON ROCK SURFACE

the rock, the pole is set between them and bolts on both sides, extending around the tree from casting to casting, clamp the pole tight. The poles thus installed are standing up well through the vagaries of severe winter conditions.

Hamilton, Ont., Can. JOHN E. MASON.

Lead Not Necessary in Slow Speed Engines

MOST SLOW SPEED engines, in my experience, do not require any lead at all. Particularly is this true of slow speed, horizontal engines of the Corliss or four-valve types. A line-and-line setting of the steam valves is all that is necessary.

Fill the clearance space with entrapped steam compressed sufficiently to afford smooth and quiet running instead of using boiler steam as when lead is given to the valves. In any case, the smaller the clearance volume, the less the amount of both lead and compression steam will be required. Operation with no lead and very little compression may be quiet and, at the same time, will be economical.

Brooklyn, N. Y. CHARLES J. MASON.

Condenser Fouling Prevented by Chlorine

WHERE CIRCULATING water is drawn from a pond, river or canal for surface condensers or where sea water is used for that purpose, more or less trouble is caused by marine growths on the outside water-cooled surfaces. In the case of fresh water, slimy deposits cause serious trouble; while with sea water the principal trouble is due to growth of mussels on the surfaces. Such growths interfere with the proper cooling of the condensate, which in turn causes the vacuum to fall.

Chlorine treatment of the water has been found most effective against either fresh or sea water growths, the water being sufficiently sterilized to render the organisms incapable of attaching themselves to the cooling surfaces. The chlorine solution employed is comparatively weak, being about 4 lb. of chlorine to a million gallons of condenser cooling water. Experience has proved that chlorine does not corrode the condenser metal work.

Chlorine should be injected into the water as far as possible from the condenser inlet, so that it becomes thoroughly mixed with the water before reaching the condenser. In this way the whole dose injected will be absorbed by the organisms in the water before it reaches the condenser. These organisms, including mussels, will not, therefore, be able to attach themselves to the metal work and will fall away and collect at the screens.

Preventing growths forming in this way results in considerable saving over the old method of scraping the organisms off and it is found that the savings made will soon pay the cost of the necessary equipment for the accomplishment of this purpose. In one English power station of 6000 kw. capacity, using sea water for cooling, the average weekly expense of chlorine treatment of the water was $12.50. The previous weekly expense, when the surfaces were hand cleaned, was $27. In addition to this, a better vacuum was maintained, less circulating water was used and less power used for pumping.

A further method which may be employed is that of introducing copper sulphate into the water. This will kill any organisms present and will not corrode metals. This should be introduced at the river pumps, only a very small quantity being required.

Mussels may be killed without use of either of these processes by raising the temperature of the circulating water above normal. In one plant, this is done by throttling the water flow through the condenser until the water temperature at the outlet is about 90 deg. F., this temperature being maintained for about 12 hr. Growths will not form if the water velocity is sufficiently high, say over 6 ft. per sec. Once formed, however, growths cannot be removed by water velocity.

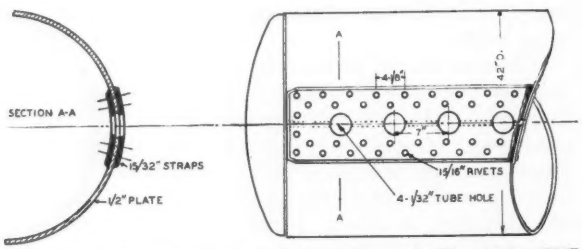
London, England. W. E. WARNER.

Questions and Answers

Calculation of Double-Butt Strap Joint

IN THE ANSWER to the question by W-H in the July 15 issue, with reference to the calculation of the efficiency of a riveted seam in which tube holes are placed in the seam, the analysis given covers only the riveted portion of the seam, no mention being made of the strength of the ligament between the tubes.

The calculation of the several methods of failure does not seem to correspond with the sketch inasmuch as the strength of four rivets in double shear is used, instead of two rivets in double shear and one in single shear. Omission is also made of the possibility of failure of the net section of plate between the rivet holes in the inner row, plus the shearing strength of one rivet in single shear in the outer row, the point at which failure would actually occur in the seam.



RIVETED JOINT IN WHICH TUBE HOLES ARE CUT THROUGH THE PLATES AND BUTT STRAPS

Accompanying sketch is to show the construction of a familiar type of boiler in which tube holes are placed in the longitudinal seam of the drum shell. As will be noted, the tube holes are placed in the center of the straps and at the junction, or butt, of the drum plate. It should also be noted that the holes in the drum plate are made slightly larger than in the straps, usually ¼ in., thus providing for expansion of the tubes against the straps alone.

To calculate the bursting pressure of the drum based on the seam in question, it is necessary to obtain the efficiency of the riveted portion of the seam as compared with the solid plate also the strength of the tube ligament, bearing in mind that two separate calculations are necessary, as failure may occur in the riveted section without respect to the tube ligament, or vice versa, depending on the design of the seam.

Using the A.S.M.E. Code values for tensile strength and rivet shear, as well as the dimensions shown in the sketch, the analysis of the riveted portion of the seam would be as follows:

A = Strength of solid plate = P × t × TS

B = Strength of plate between rivet holes = (P-d) × t × TS

C = Shearing strength of rivets in double shear = N × S × a.

Further analysis with respect to crushing of plate or straps in front of rivets is not necessary in a seam having these dimensions, as the values will be found to be considerably higher for them than for the parts calculated.

Let P = pitch of rivets for any like unit = 4⅛ = 4.125 in.

t = thickness of plate = ½ = 0.5 in.

TS = tensile strength per sq. in. of plate = 55,000 lb. per sq. in.

d = diameter of rivet = 15/16 = 0.9375

N = number of rivets in double shear = 2

S = shearing strength of rivets in double shear = 88,000 lb. per sq. in.

a = cross-sectional area of rivets in sq. in. = 0.6903

R = radius of drum = 21 in.

Then A = 4.125 × 0.5 × 55,000 = 113,437

B = (4.125 — 0.9375) × 0.5 × 55,000 = 87,656

C = 2 × 88,000 × 0.6903 = 121,490

Dividing B by A, we have $\frac{87,656}{113,437} = 0.772 = 77.2$ per cent seam efficiency.

As noted above, the tube holes are located at the butt of the shell plate, so that the strength of the ligament depends on the net section of the butt straps between tube holes, the shell plate having no bearing on the strength of this part of the seam. As the tube holes are spaced at 7-in. centers, the net section remaining would be $7 - 4\frac{1}{32}$, or $2\frac{31}{32} = 2.968$ in., and the efficiency would then be (7 — 4.125) ÷ 7 or 0.424 = 42.4 per cent.

At first glance, the tube ligament efficiency of 42.4 per cent would seem to be rather low as compared with the riveted seam efficiency of 77.2 per cent. We should bear in mind, however, that when determining the bursting pressure of the drum based on the riveted seam, the resistance is afforded by the shell plate, whereas the resisting element in the tube ligament is the combined thickness of the straps.

TS × t × E ÷ R or 55,000 × 0.5 × 0.772 ÷ 21 = 1010

where E = efficiency of joint = 0.772

and for the tube ligament we have

55,000 × 0.9375 × 0.424 ÷ 21 = 1041, showing that failure would occur at the riveted portion of the seam before that of the tube ligament.

The style of seam shown in the sketch is one in which all rivets are in equal pitch and double shear. Boiler drums will be found frequently, however, in which the conventional seam is used, that is, with straps of unequal width and the outer row of rivets in single shear and wide pitch, as shown in the sketch of the July 15

issue. The calculation for riveted seam efficiency is primarily the same in either style of seam and the strength of the tube ligament must be separately calculated in either case.

Newark, N. J. GEORGE E. DAVIS.

Remedy for Excitation Loss

I AM RUNNING a 16-kw., 1250-r.p.m., 110-v. generator which is used for lighting our mill. Occasionally it fails to generate and the fields have to be excited. This we do by placing a fuse across the field and brush terminals. We have used a 6-v. storage battery but short-circuiting with the fuse is much easier. I should like to know why the fields lose their excitation when the generator is shut down for only a few hours. Perhaps there is a better way of exciting the fields. R. W. M.

A. There are a number of reasons why generators fail to generate. From your letter, we assume that the failures to which you refer always occur after the generator has been shut down for some time. Primarily the trouble here is lack of residual magnetism but in itself the trouble may be due to several different things.

It depends somewhat upon the character of the iron in the field coils. In some cases, the permeability of the iron is such that it will not hold sufficient residual magnetism to carry the machine over extended periods of idleness. Sometimes, if the machine is in a location where it is subject to considerable vibration, the vibration may be the cause of the loss of magnetism.

Again, it may be due to a reversed field coil connection which would cause that particular coil to oppose or buck the residual magnetism of the machine and cause it to diminish to a value so small that the field current resulting from the initial induced terminal voltage is insufficient to produce an appreciable increase in the flux due to residual magnetism.

Sometimes a generator will fail to build up because the shunt field resistance is too high. When this condition exists, the voltmeter reading after the field circuit is closed increases but slightly above its initial reading and then ceases to increase. The remedy in this case is to reduce the resistance of the shunt field circuit by cutting out resistance in the field rheostat. From your inquiry, however, we do not believe the cause of your trouble to be high field resistance.

If the connections of the shunt field are such that the initial field current, primarily due to residual magnetism, opposes or bucks the residual magnetism, the machine cannot build up. When this condition exists, the voltmeter reading decreases when the shunt field connection is made and the remedy is, obviously, to reverse the shunt field connections. This condition and corrective procedure, of course, applies only in the case of a new machine just shipped from the factory. In a machine that has been in regular operation, the shunt field connections with respect to the residual magnetism should be correct and no reversing of the shunt field connection should be necessary.

We do not know of any better method of excitation than the one you are using. We assume that you place the fuse across the terminal of the series field winding and the brush in such a manner as to cause the series field to act as a shunt field until sufficient current is generated to blow the fuse. This is a simple method and, in the case of a small machine such as yours, the expense of the fuse is negligible.

With machines of large capacity, it would be better to excite the shunt field winding by means of a dry or storage battery.

Furnace Construction for Natural Gas

REPLY TO H. A. M. in regard to furnace construction for natural gas published in the September 15 issue, contains much valuable information. There is one point, however, on which an exchange of view or experiences might be profitable.

Our company has secured better results by having baffles on the third row of tubes. Twelve parallel-flow, water-tube boilers with dutch-oven furnaces are operated in three different plants of the company. Baffles have been tried on both first and third rows of tubes.

We have one battery of two boilers of about 250 rated horsepower each, which are set lower than usual, the combustion space being not over 1½ cu. ft. per rated horsepower, which is quite small. We are securing better service from this battery with the baffles on the third row of tubes. The CO_2 record on this battery averages better than 8 per cent out of a possible 11.6 per cent. It is true that we can get a little better combustion from this battery with bottom baffling but under that condition the boilers cannot be fired hard without injuring the brick work badly.

If water screens and high-temperature refractory brick were employed there would, of course, be less furnace trouble. The following is copied from "Steam Boilers"—1927, published by the American Gas Association. Baffling the lower row of tubes in horizontal, water-tube boilers is undesirable and such baffles, if possible, should be changed to the second or third row of tubes. This will not only increase the overload capacity of the boiler but will insure better efficiency by exposing more heat absorbing surface to the radiant heat of the furnace. It may be noted here that increasing the heat absorbing surface exposed to the furnace lowers the furnace temperature appreciably, tending to promote longer life of the brick work.

Sugar Grove, Ohio. H. COONEY.

Acid Removal of Lime Deposits

Our hot water supply pipes are accumulating rust and deposits from the water and are becoming clogged. The pipes range in size from 2 in. down, most of them being concealed in the walls of our five-story building.

How can we remove the deposited material from the pipes? B. A.

A. Your trouble is probably due to lime deposits as well as rust.

To remove these deposits from your hot water system, at some time that would be convenient, drain your system; then, after closing all outlets, fill it full of a 5 per cent solution of hydrochloric acid, known commercially as muriatic acid. Let this stand for about 48 hr., then drain and flush it well with clear water while all outlets are open.

It will be well, as a further precaution, to fill the system with clear water and let it remain in that condition for a few hours before a final flushing after which it may be put into service again.

In order to avoid a repetition of this trouble, it would be wise to install a water softener.

Editorial Comment

The Value of Automatic Hydroelectric Plants

Automatic and partially automatic hydroelectric plants have been in service for a sufficient length of time to warrant some conclusions as to their value. A large number of such installations is now in successful operation, some with more than 10 yr. experience behind them. After an exhaustive survey of the subject, the Hydraulic Power Committee of the N.E.L.A. has issued a report tabulating the principal characteristics of 104 automatic and partially automatic plants, which presents the conclusion that the automatic idea is a success both technically and economically.

Power Plant Engineering has published during the past few years much technical information on the operation of automatic hydroelectric equipment in general and on particular installations. Readers of these articles should be interested, therefore, in some of the conclusions presented in the Hydraulic Power Committee report.

In no instance during the survey, according to the report, did an operating company state that partial or full automatic operation had been abandoned after a trial. "Operating companies will do well therefore to examine carefully the conditions surrounding every manually operated installation to see whether operating expense can be reduced by this method," the report continues. "Decreasing costs of steam generation are bringing many hydroelectric plants close to the economical dead-line. Older installations are facing large outlays of capital for new water wheels or pipe lines to replace those worn out or inefficient. Automatic operation may solve the problem and keep the water power working with increased efficiency and financial return.

"As interconnected systems grow and operation of plants and transmission lines becomes more complicated thereby, the time may be fast approaching when groups of large hydroelectric plants will need to be automatic in order to keep them together during system disturbances and restore service in a minimum time after interruptions. Electrical and mechanical devices are more dependable in emergencies than the human mind and they act instantly ..... The handicap of the isolation of each plant must be overcome and more automatic equipment will aid."

This is a splendid summary of the principal advantages of automatic control but the concluding statement is even more significant. "Automatic operation appeals strongly to one interested in the development of men. It frees the operator from the four walls of his station, giving him greater responsibility and chance for growth." This is not the least important benefit conferred by automatic equipment. Anything that will enable the engineer to broaden his outlook and raise the standards of his own work and of his profession, at the same time bringing about more economical plant operation, deserves the most careful consideration of the entire industry.

Cash Dividends of Quiet Hours

Some power plant organizations, particularly those of office buildings and hotels, forget that the functions of a chief power plant engineer should be largely executive. While the heads of their accounting, supply and other departments are freed from routine attention to small and greatly varied details in their several departments, it appears that the chiefs of their power plants are expected to be on call for personal consultation about the most trivial matters.

Recently, in visiting the power plant of one of the newest and largest hotels, we found it difficult not only to find the chief but to have more than a few minutes conversation with him without interruption. One patron had trouble with one of his electrical sockets, another with ice water and a third had discovered a leaky faucet. Everything must have the chief's immediate attention. A hotel is an excellent field for the study of human nature. Fussy patronesses, who have nothing else to think about, can pack a lot of trouble into a short space of time, for service for which they feel that they are paying.

As an executive, the chief should be freed from handling details. His office should be the clearing house for such matters but they should be delegated to competent assistants. The chief's business is to lay down policies, outline methods of operation and supply checks, such as recording devices, to enable him to oversee properly the working of his department. He must know every detail of operation and maintenance procedure, not as a routine task but rather as a study made from the records which come before him.

Without coördination and analysis, operation records are of little value. Without careful analysis of records, preventable losses may pass unobserved. Without available time, adequate analysis is impossible.

Like many other men who are harassed with varied and rapidly changing detail, the chief of our visit feels that he hasn't time to read power magazines. By the time he reaches home at night, he is so tired out by the jumping about to which he has been subject all day that he has no desire to read and during the day he has no opportunity. He cannot keep up to date; therefore he can depend only upon chance for improved methods to be brought to his attention.

A chief's time has such potential value that it should be employed in his most effective function of supervision.

As in the history of nations refinement of social conditions has been brought about largely by those who had time to think, so refinement of an organization, such as the power plant, may be expected to be brought about when the executive is exempt from routine duties of petty detail and is left free to study, think and plan, at least a reasonable portion of the time.

Off Duty

In the reception room of the Arthur D. Little research laboratories at Cambridge, there is on display in a glass case an interesting exhibit which never fails to attract the attention of the visitor waiting there for an appointment. At the top of this exhibit is the inscription:

"You can't make a silk purse out of a sow's ear."

Then, directly underneath, to show the fallacy of this time-worn adage, there is shown both a sow's ear and a silk purse made from it together with samples of all the intermediate products which entered into the making of this artificial silk purse. Thus, modern chemistry has shattered another popularly accepted proverb.

Many beliefs and practices are being shattered these days to good purpose and so far as we are concerned there are many more that should be bombarded. There are some things, however, which it is probable, nothing can change. Just now, for instance, a great effort is being made by various agencies, mostly the haberdashers and dispensers of men's clothes, to make suspenders respectable.

The suspender of today is quite a different affair from what it was a few years ago. From a drab, anemic, purely utilitarian piece of lingerie it used to be, it has blossomed forth in passionate hues of purple and red and yellow. It is emblazoned with gaudy designs in gold and its inch of elastic band has given way to broad swaths of splashing color visible at a distance of several light years. Where before a tin clasp was sufficient to provide adjustment for expansion, today the hardware on suspenders must be nothing short of gold and platinum. They are sold in ensembles together with garters in plush lined caskets. Indeed, the old reliable galluses have undergone such a transformation as to wring anguish from the heart of the old timers who wore them for utility's sake. They wore them concealed from the public gaze but today, these new fangled supporters are to be worn shamelessly in full daylight, exposed to the eyes of the multitude, or else why the adornment?

Alas, we feel that this attempt to make galluses respectable is just so much time wasted. The suspender, in our opinion, is in the same class with the word victuals (pronounced vittals) it can never be made respectable, much less dignified. Suspenders are, always were, and always will be, simply a means to hold up one's pants by—they can never be anything else. Any attempt to beautify suspenders, to make them *objets d' art* is very much like trying to make a silk purse out of a sow's ear and although that has been accomplished, we question whether the combined resources of Arthur D. Little, J. Walter Thompson and Paul Poiret could make suspenders beautiful.

It seems tragic that with all man's inventive ability he has been unable to invent anything better to wear than a pair a galluses. Granted they are exceedingly utilitarian and that they uphold man's dignity it seems that something more scientific could have been developed to overcome the effect of gravity on the covering for man's lower anatomy.

The trouble lies not in any lack of ingenuity but in his inherent fear of ridicule by his fellows. There is scarcely a man among us who does not admit the utter discomfort of men's wearing apparel particularly in summer but outside of a few publicity hounds and pseudo artists who parade *en mass* in flamboyant pyjamas, no one is courageous enough to run the gauntlet of ridicule by appearing in public in anything but the conventional garb worn by a hundred million males from Nome to Patagonia. It is not that his inclinations are as drab as his public garb, indeed, they are quite the opposite and at the slightest provocation he will reveal his love for gaudy display. His suppressed desires often come to the surface in pitiful ways. In the privacy of his boudoir, he all but goes into a chromatic debauch and arrays his angular frame in bizarre night clothes that violate every rule of color combination, but to him, that does not matter for it satisfies his instinctive craving for brilliant hues. His modern underwear is no less gaudy. Far different from the virgin whiteness of his "undies" of a decade ago, today beneath his conservative "undertaker type" street clothes he wears lingerie which if exposed would put the spectrum to shame.

No doubt he would like to sport a pink coat trimmed with lavender for street wear but he hasn't the courage so he partially satisfies his barbaric tastes for color by wearing the most grotesque underwear that the aniline dye industry is capable of producing. He would love to wear them out in the open but he is afraid his fellow men would laugh at him and he could not endure that.

It is no doubt the herd instinct in him that is responsible for this condition—the tendency to pack together, to follow the leader, never to stray far from the common herd. Woman is different—she has less of the herd instinct and more of the feline's individualism. This individualism is apparent in her every action, in her clothes, her inherent suspicion of all other women, in her everlasting desire to be different. She too has affected suspenders in recent times but note that her's are different. She incorporates them in her street dress, and wears them gracefully, artistically. For her they become things of beauty and grace, attractive to behold but not utilitarian in their purpose. But for man—well, as we said before, for him they can never be anything but just something to hold up his trousers. They are, in short, a means to an end, nothing more. As such they should be worn exposed only during a total eclipse.

In our industry, particularly where the cost of the plant, invested capital, bears such a large ratio to the income, it is particularly important that the engineer consider dollar efficiency. No engineering problem, no matter how technical, is completely solved until the answer has been worked out in dollars and cents, and in this, all items involved must be considered. At this time more than ever before, technical efficiency is not the final answer, and the engineers who are planning, constructing and operating our properties must take a wider view. Our industry is demanding new money at a continually increasing rate and by forecasting the future from accomplishments of the past, it is evident that within another generation the amount of money required annually will be stupendous if our industry continues growing as it has in the past and unless we greatly reduce our unit investment costs.—Alex D. Bailey in an address before the N.E.L.A. convention.

Power Plant Engineering Developments and News

Cleveland Welcomes N. A. P. E. Convention

EDUCATIONAL CAMPAIGN STRESSED AT FORTY-EIGHTH NATIONAL CONVENTION HELD SEPTEMBER 8 TO 12 AT CLEVELAND, OHIO. CHAS. A. DOBSON ELECTED NATIONAL PRESIDENT AND LISLE A. PIERSON, VICE-PRESIDENT. KANSAS CITY NEXT CONVENTION CITY

WITH a justifiable pride in the municipal development of the lakefront and an enthusiasm for which the city is noted, the Forty-eighth Annual Convention of the National Association of Power Engineers was welcomed to Cleveland by Hon. John Marshall, mayor of the city, with a sincere wish that the association would not wait another 33 yr. for a return visit. This convention, held September 8 to 12, was the first national meeting held in the city since 1897.

Facilities both for convention and exhibition purposes proved ideal and the sessions proceeded with dispatch and enthusiasm from the registration of delegates to the election and installation of officers on Friday. Sightseeing facilities in Cleveland are excellent and a carefully planned program by the entertainment committee took up the spare time of ladies and visitors not interested in the business sessions of the association or Ladies Auxiliary.

At the election of officers, Chas. A. Dobson, Tenn. No. 6, National vice-president, was unanimously elected president, and Lisle A. Pierson, Mich. No. 7, was unanimously elected vice-president on the third ballot. The latter was opposed by John P. Brown, Ohio, No. 36, and Thos. H. Clark, Mass. No. 32, both of whom withdrew in favor of Mr. Pierson after the second ballot.

Fred W. Raven, Ill. No. 1, was elected National Secretary and Herbert A. Wilcox, N. J. No. 3, National Conductor, without opposition. Samuel B. Force, for 26 yr. National Treasurer, was reëlected by a unanimous vote on the second ballot after Bert W. Howell, N. Y. No. 16, had withdrawn in his favor. S. G. Roberts, Ga. No. 1, was elected doorkeeper in the same manner after Chas. Iden, Ohio No. 10, and Joseph Howle, Ohio No. 519, withdrew after the first ballot. The most actively contested election was that of national trustee for a period of 5 yr. After the first ballot, the present incumbent, Harold H. Hilton, Cal. No. 2, withdrew in favor of Walter H. Damon, Mass. No. 4. On the second ballot, John Topham, Cal. No. 2, also withdrew and Mr. Damon was elected unanimously. Tom Clark was appointed

DELEGATES, EXHIBITORS AND FRIENDS AT THE 48TH N.A.P.E. CONVENTION

special deputy by the incoming president. Throughout the elections the slogan "Operating engineers for officers" was used effectively.

Kansas City was selected as the convention city for 1931 by a slight margin on the first ballot. Both Minneapolis and Des Moines were active in the contest, Minneapolis, in fact, being the first choice of the Board of Trustees and National Exhibitors Association. In order to avoid confusion and assure adequate facilities in the convention city, the constitution provides for a first, second and third choice of cities to be made by a joint committee of the Board of Trustees and officers of the N. E. A.

These three cities are submitted to the delegates and voted upon. Kansas City was the second choice of this joint committee but the first choice of the assembled delegates. Although Minneapolis offers certain advantages from a convention and exhibition standpoint, the Minnesota state exhibition has been held annually in spite of the opposition of the National body to state shows and this undoubtedly played a large part in influencing the vote of the assembled delegates.

Taken as a whole, the convention went smoothly with perfect coördination of all committees. Nearly 300 delegates attended and following registration and a reception on Monday, the first session was opened on Tuesday morning with Vice-Chairman Joseph Howle of the local convention committee in the chair. After the invocation by Rev. Walter H. Stark of the Pilgrim Congregational Church of Cleveland, Hon. John Marshall welcomed both delegates and visitors to the city, extending the freedom of the city to them and offering them the courteous coöperation of all city employes to those interested in inspecting any or all of the engineering features of the many municipal enterprises, in particular Fairmont Pumping Station, a model of modern pumping station design.

In thanking the mayor for his welcome, Pres. James A. McDevitt outlined the fundamental problems of the organization and engineers and sketched their importance in industry and business, in particular changes which have taken place since the last convention at Cleveland held 33 yr. ago. Past-president Naylor of Chicago, still an active engineer, presided at that convention and Pres. McDevitt used this point to illustrate the rapid rate at which power plant practice is developing, in the short period of but part of a single lifetime the industry has changed completely.

This same point was also emphasized by Roy B. Robinette of the Cleveland Chamber of Commerce. The engineer is now a vital factor in the economic and social development of the country. He sketched the early and various stages of our country's development and pointed out some of the more important parts that the engineer plays in modern commerce and industry. But a few of the most important of the engineer's duties to society were mentioned because, as he said, "it would be much simpler to name the very few things the engineer does not do rather than the many things that he does do."

Vice-Pres. Chas. A. Dobson expressed appreciation of Mr. Robinette's compliments to the engineer and outlined some of the major problems confronting the organization if it is to carry on its share of this world-wide engineering progress.

Past-Pres. Thos. R. Herlihy further enlarged on the problems confronting the association and went far back in history to trace the rise and fall of empires, the activity and enthusiasm that led to their rise and the stagnation and general apathy for change that led to their fall. Organizations, like empires, also rise and fall and he expressed the hope that the N.A.P.E. would rise to greater heights and accomplish greater things during the years to come.

The meeting was then turned over to Pres. McDevitt and after the tribute to the Flag by Sec. Fred. Raven and the announcements the first session was adjourned. After the report of the Credential Committee and seating the delegates at the afternoon session, the National President's report was read.

"Education is our chief motive and therefore our

DELEGATES, EXHIBITORS AND FRIENDS AT THE 48TH N.A.P.E. CONVENTION

most important subject," said Pres. McDevitt. "During the past year I have had an opportunity that no national president of recent years has had—of being located in the same city which quarters the main office of the National Educational Committee and have had the chance to observe, at first hand, the various activities of this committee. To be frank and brief, I can offer nothing that would improve the work now being done under the capable and intelligent direction of Brother N. K. Chamberlain." Pres. McDevitt refers to the consolidation of the educational, administration and publication departments which was voted at Chattanooga last year and which has been started and will be entirely completed by next spring after certain office leases expire so that the change can be made. "Merging is today considered the last word in bringing about coördination, dispensing with duplication of effort and enabling the entire force to benefit by coöperative planning," continued Pres. McDevitt.

Referring to criticism of the cost of conventions, he said in part: "The mileage and expenses of the Chattanooga convention were around $19,000. These figures are from the annual reports of the secretary and treasurer and show the cost of the convention to be below 50 per cent of our income. The biggest item in our expense account is salaries. These total, at present, over $20,000. This does not include office expenses such as rent, light, telephone, postage, etc., which runs the bill close to $25,000. If the offices were properly consolidated and one man put in charge as office manager, we could save 25 per cent, and get better service and more efficiency.' State power shows were also again discouraged by the president in order to maintain the prestige and advancement of the national body.

During the past year, the association sent two delegates, Wm. J. Reynolds and Fredrick Felderman, to the A.S.M.E. Golden Jubilee and Pres. McDevitt urged action in connection with their own Golden Jubilee which is but two years off and which coincides with the bicentenary celebration of the birth of George Washington which will be celebrated in Washington, D. C., and probably many other cities.

In accordance with the requirements of the constitution, Vice-President Chas. A. Dobson reported the addition of six new associations, the reinstatement of two, the loss of one and the consolidation of two, Ohio Nos. 5 and 19 to form Ohio No. 519. One of the principal duties of the vice-president is the maintenance of membership and educational programs initiated by some locals to get new members and hold the present members were outlined by him. Efforts of the Promotional Committee were outlined in detail by N. K. Chamberlain, chairman of the Promotion Committee. The chairmanship of this committee was changed following the Chattanooga Convention because the Board of Trustees felt that former Chairman Thomas Thurston should devote all his time to his editorial duties. The report of National Secretary Fred W. Raven showed 26 flag winners for membership gains, ranging from Pa. No. 1 with 157 to Tenn. No. 4 and 10.

"Education has always been an important link in the membership gain and you will be gratified to learn that after nearly four years of directed effort our policies are at last being justified by results," said Herbert A. Russell, chairman of the National Educational Committee. "We have sensed a general change in attitude toward the National Educational Department this year and believe that the time has come when there is such a widespread realization of the importance of a national program that the matter is no longer an issue. The very existence of an association depends upon the perpetuance of a national program of education for our members. The program itself will be shaped to fit the needs and desires of the members when their individual realization of its vital importance leads them to make personal use of it."

" . . . as far as the general program is concerned, it (the merit system) can never be made entirely self-supporting any more than can any public school, correspondence school or college system. Public schools are an expense to the country but no one will deny their imperative necessity. They are an investment in progress and exactly the same thing applies to the educational program of the N.A.P.E." The average yearly cost since 1927 has been $8,395.14. Some 1879 merit books have been sold and there are 774 active students.

An extensive survey by the committee showed possibilities of coöperation and help from State and Federal Educational Boards. While three states are using the merit system as a basis for license examinations, there is a possibility that the merit system can be tied in with state vocational service. This committee also recommended the purchase of a coal calorimeter to test coal samples, the idea being to extend this later and set up a complete laboratory to serve both members and manufacturers.

A considerable part of the Wednesday morning session was devoted to association business largely in connection with a program of education for advancing the interests of the private power plant and plans pertaining to the Washington bicentennial celebration. Reports of the national deputies were then heard and showed generally encouraging conditions throughout the country. This session was adjourned after a brief address by Mr. Lewis of the Ohio State License Board. He praised the N.A.P.E. for the part it played in obtaining the license law and produced figures to show the improvement in the accident rate since the laws were put into effect.

In the afternoon, Arthur B. Oday, illuminating engineer of the General Electric Co., presented a paper on the Progress of Lighting. Although the history of lighting goes back to the dawn of history, illumination really began with the development of the Mazda lamp. Today a careful study of conditions leads to lighting methods which reproduce daylight. As a decorative agent, it is being utilized by architects and designers and has been applied to outdoor recreation and sports such as golf and baseball. Great strides may be expected in this line within the next year or two. Production of ultra-violet rays has been significant from a medical standpoint and has already entailed much research. The immediate problem is the production of equipment which will combine the proper proportions to give good visibility and at the same time promote health. Following this address the meeting adjourned to visit Nela Park, laboratory headquarters of the National Lamp Works of the General Electric Co. Wednesday night, the N.E.A. gave an entertainment for delegates and visitors.

At the Thursday morning session, Sec.-Treas. James D. Taylor of the Life and Accident Insurance, made an announcement of the action taken by them at a meeting the night before when this division was dissolved. Following this and some committee reports, Dan McQuaid, U. S. Deputy, spoke on the Future of Engineering. The obligations of the new age are great and challenge both the incoming youth and those who have reached maturity.

Later, a joint meeting was held with the Ladies Auxiliary and $100 voted by the assembly to the Pension Fund. The session was adjourned after memorial services for departed members were conducted by Secretary Raven.

On Thursday afternoon, the Ways and Means Committee reported and their recommendations were acted on by the delegates. Among the most important were: a continuous promotion program under the direction of the educational department; an appropriation of $10,000 for education and $3000 for promotion and a $0.05 mileage rate to the delegates for some 192,527 miles traveled by 298 delegates, the four Cleveland delegates are not, of course, included. Friday morning and most of the afternoon were taken up almost entirely with the election of officers. In the evening, the public installation of officers preceded the grand ball in the ball room of the Auditorium.

The Cleveland Power and Mechanical Exposition with some 100 exhibitors and sponsored by the National Exhibitors Association, was well attended and attractively arranged. The following were elected officers of the N.E.A. for the coming year: President, W. H. Gaylord, Quigley Furnace Specialty Co.; vice-president, John H. Allen, Everlasting Valve Co.; treasurer, Fred G. Jolley, Jenkins Bros.; secretary, F. N. Chapman, A. Leschen & Sons Rope Co. The Executive Committee is: W. H. Wilson, Roto Co., chairman; J. N. Troescher, John A. Roebling Sons Co.; C. J. Burrage, Ashton Valve Co.; G. C. Freeman, Chicago Faucet Co.; B. F. Cassidy, Garratt-Calahan Co.

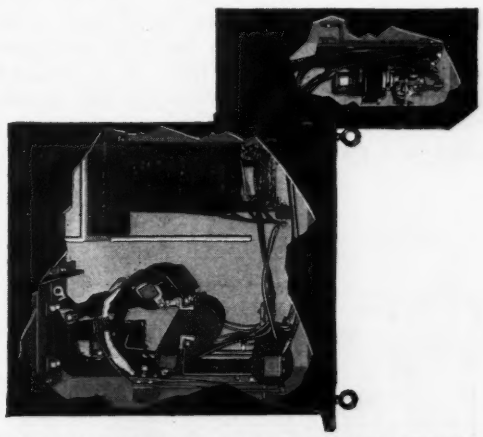
Full Voltage Motor Starter

INTENDED FOR use in across-the-line starting of squirrel cage and synchronous motors, a new 2300-v. full voltage magnetic starter has recently been placed on the market by the Electric Controller & Mfg. Co. of Cleveland, Ohio. This starter, complete with overload relays and a self contained potential transformer (to secure 220 v. for the control circuit) may be used also to control the primary of slip ring motors. It is built for reversing, non-reversing and plugging applications.

As shown in the accompanying illustration, the enclosing case is a heavy welded steel tank, which houses the completely wired unit. A longer tank containing two magnetic contactors, mounted back to back and mechanically interlocked, is supplied for reversing, non-reversing and plugging applications. This unit construction provides a flameproof, corrosionproof and dustproof installation that may be mounted anywhere with perfect safety. It is not necessary to build an expensive control room for these starters. Frequently, it will prove very economical to mount them out in the plant alongside the motors they control. It is perfectly safe to do this, because all live parts are totally enclosed and grounding the case provides a shockproof installation.

These starters are available in two sizes, the No. 2 and No. 3 sizes, with maximum ratings of 600 hp. and 1200 hp. respectively. They may be controlled from a type M master switch which can be arranged to provide low voltage release or low voltage protection. The starters may also be controlled from float switches, pressure regulators, altitude regulators and similar actuating devices.

The design of this starter is radically different from the switchboard circuit breaker type of starter commonly used in the past for full voltage starting of high voltage a.c. motors. There are no bell cranks, toggle mechanisms or lever systems between the magnet armature and movable contact arm. The magnet armature, carrying the movable contact arm, is direct acting and is supported by only one large bearing pin and since the entire unit is totally oil-immersed, all working parts are always well lubricated and protected from dust and corrosion. This insures that the equipment is ready for operation at any time, whether it is out of service for a few minutes or for several months.



CUT AWAY VIEW OF E. C. & M. FULL VOLTAGE MAGNETIC STARTER

All contacts used on this, the type ZHS full voltage magnetic starter, are likewise different from previous 2300 v. designs made by this company. They open and close the circuit with a wiping and rolling action, are duplicate and are easily renewable.

Dry Rectifier Replaces M-G. Set in Switching Equipment

USE OF A copper-oxide rectifier in place of the field-flashing motor-generator set distinguishes a new design of automatic switching equipment for synchronous converters in mine service, announced by the General Electric Co. The new switching equipment was exhibited at the recent American Mining Congress, Cincinnati, O.

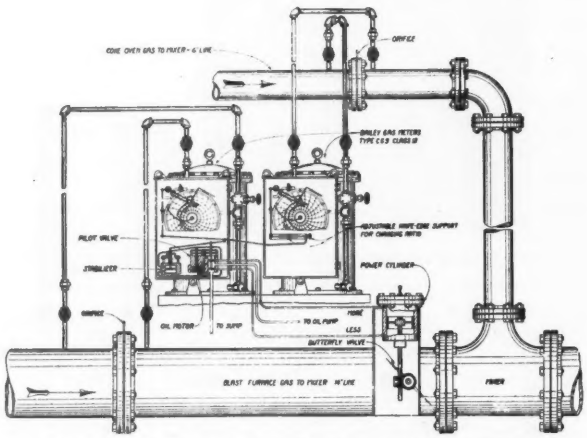
A number of improvements over older models are incorporated, the most important of which is the use of the copper-oxide rectifier which is connected to the a.c. power supply, thereby providing a definite source

of power at correct polarity with which to flash the field. The field flashing contactor and the main-field contactors are still used. The rectifier is very small and is mounted on the back of the starting and running panel. Its use eliminates some of the difficulties encountered with a motor-generator set.

The equipment as a whole provides protection to the substation equipment in the event of the following abnormal conditions: a.c. and d.c. overcurrent; a.c. undervoltage and reverse phase; d.c. reverse polarity; d.c. reverse power; incomplete start; overheated bearings and windings; single phase or unbalanced phase currents; overspeed and wrong brush position.

Automatic Ratio Control

RATIO CONTROL for the mixing of gases or liquids in any desired proportion has been announced by Bailey Meter Co., Cleveland, Ohio. It is designed for application in steel mills, oil refineries and process industries where mixture of fluids must be definitely proportioned in a given ratio to secure best results. It is



RATIO CONTROL AS INSTALLED IN AN EASTERN STEEL MILL

intended to be applied to proportioning of air and fuel for combustion in industrial furnaces, liquid or gaseous fuels or various combinations of the two to form a low cost fuel and secure the best efficiency consistent with economy.

Installation of this ratio control in a steel mill is shown in the illustration. Here it is used to proportion automatically blast furnace gas too lean and low in heat value for satisfactory fuel and coke oven gas too valuable to use alone, whereas a mixture of two parts blast furnace gas to one of coke oven gas forms an ideal low cost fuel.

The control is actuated by hydraulic pressure. A Bailey gas meter is connected to the coke oven gas line to reflect any change in rate of flow in that line. The recording mechanism of this meter is connected through a system of linkage to a pilot valve, stabilizer and another gas meter, the latter connected to the blast furnace gas line. If the flow of coke oven gas increases, the linkage moves to raise the pilot valve to allow oil pressure to be applied to the "more" side of the power cylinder. At the same time, this movement opens the "less" side of the power cylinder to drain.

The stabilizer is intended to counteract the impulse given by the coke oven gas meter. This effect is produced by connecting the "more" oil line to the upper chamber of the stabilizer and the "less" line to its lower chamber. Pressure on the "more" line with the "less" side open to drain causes the stabilizer piston to move down, tends to equalize pressures on either side of the stabilizer, causing it to take a neutral position and permits a quick control without bursting. Any desired ratio between the parts of a mixture can be obtained, it is stated, by selection of proper orifices and adjustment of the linkage.

Multi-port Valve for 125 lb. Pressure

BY CERTAIN CHANGES and improvements in design, the Cochrane multi-port back-pressure valve has now been adapted to pressures as high as 125 lb. per

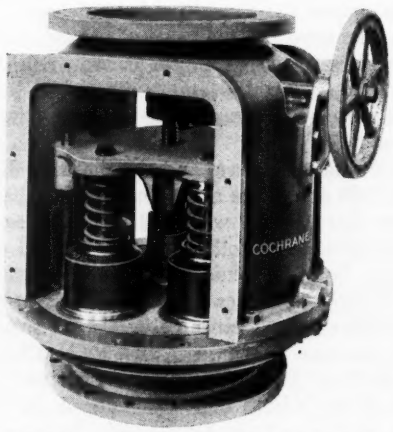


FIG. 1. GENERAL DESIGN OF MULTI-PORT VALVE FOR 125 LB. PRESSURE

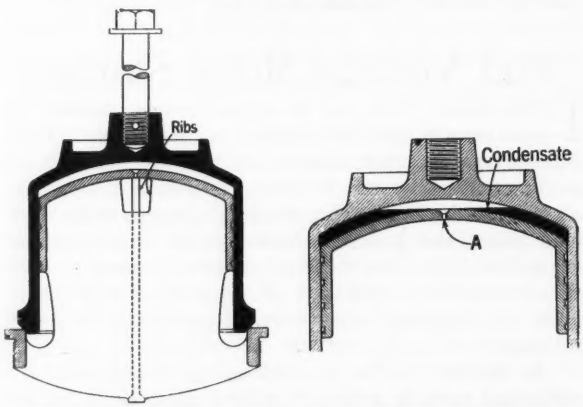


FIG. 2. SECTIONS OF CUSHION CHAMBER AND VALVE

sq. in. for control of steam from turbines or reducing valves for use in processes or heating systems.

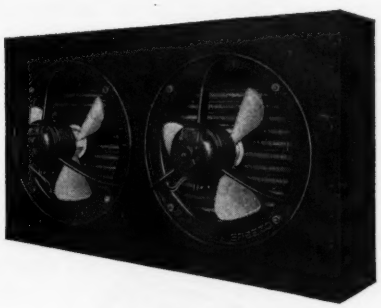
Construction of the valve is shown herewith. In the new arrangement, the pressure acts only on an annular area between valve seat and inside of valve cylinder. Pressure building up in the space between the head of the valve cylinder and the plunger which forms part of the valve seat, lifts the valve. This pressure builds up or escapes slowly through a small hole A in the top of

the plunger. This, it is stated, eliminates any tendency toward chattering. Cushioning and valve control action are brought about by the leakage of steam through A and the operation of the valve does not depend on water for dashpot action, hence it is suitable for use with air, vapor or superheated steam. Only as much condensate is retained in the chamber as is useful in sealing and lubricating the clearance.

For high pressure work, the valve is supplied with nichrome iron or cast-steel body, Everbrite valve discs, seats and cushion chambers, nitrided spindle and alloy steel springs. The spindle is fitted with a roller thrust bearing and the hand wheel with a reduction gear, to facilitate adjustment of the valve in service under heavy back pressure. This valve is a product of Cochrane Corp., Philadelphia, Pa.

Twin 16-In. Unit Heater

TWIN 16-IN. BREEZO-FIN UNIT HEATER as illustrated has recently been placed on the market by Buffalo Forge Co., Buffalo, N. Y. This unit is equipped with the Aero-fin heating coil and only one set of steam



TWIN UNIT HEATER

and drip connections is needed. It is arranged so that one of the 16-in. fans may be shut down to reduce temperature and steam consumption. It is designed to be quiet in operation and to have low B.t.u. cost.

The heater is made in three sizes: 3505 c.f.m., with ⅛-hp. motor per fan at 1440 r.p.m.; 2800 c.f.m., 1/10-hp. motor per fan at 1150 r.p.m.; 2070 c.f.m., 1/20-hp. motor per fan at 860 r.p.m. These vary in heat capacity from about 400,000 B.t.u. per hour to about 150,000 B.t.u. per hour, depending on air temperature, steam pressure and final temperature. The units are 3 ft. 8½ in. long, 2 ft. 5 in. high and 10 in. thick.

Pneumatic Ash Removal

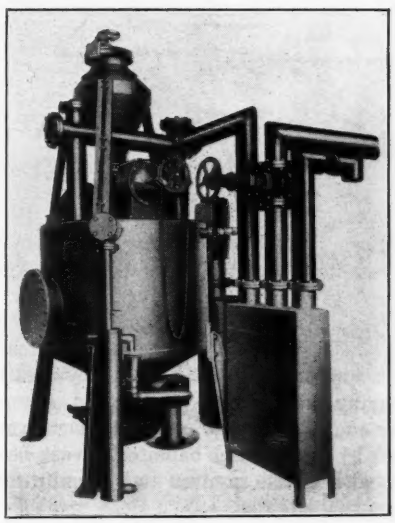
FOR REMOVING ashes from boiler plants in basements a system has recently been placed on the market by Allen Air Appliance Co., Inc., of New York City, which sucks the ashes into an air-tight steel truck body known as the "dump unit." Power is furnished either from a plant on a second truck, known as the "power unit," or where frequent removal is required, by a plant installed in the building. For such permanent service a pipe line is installed from basement to street level, while for use with the power unit truck a flexible pipe is run temporarily from truck to ash storage. By separating power and dump units, the former can serve several of the latter, thus keeping the power plant in continuous use while the dump trucks are traveling to and from the dump location.

Evidently, the system may be used for handling any dry material which will pass freely through the conduit thus making it serviceable for many kinds of industrial operations as well as for ash handling.

Types NA-3 and NA-4 Acetylene Generators

TWO IMPROVED TYPES of non-automatic stationary acetylene generators for supplying large volumes of acetylene have recently been placed on the market. These generators are each made in two sizes, having 500 lb. and 1000 lb. carbide capacity. They are designed for large industrial plants where oxwelding and cutting are used and where oxygen and acetylene are piped to stations convenient to operators.

The Oxweld Type NA-3 acetylene generator, shown in the illustration, is for plants using low-pressure welding and cutting apparatus and delivers to a storage holder which is weighted to supply acetylene to the shop piping system at a pressure of 20 in. water column.



TYPE NA-3 ACETYLENE GENERATOR

Except for one automatic feature, all operations having to do with the starting and stopping of carbide feed must be performed by the generator attendant. For this reason, the generator is classed as non-automatic; that is, the carbide feed is not automatically governed by, or interlocked with the immediate acetylene requirements.

The Type NA-4 generator is similar to the Type NA-3 with the addition of an Oxweld automatic booster system to deliver acetylene to the shop piping system at pressures not to exceed the permissible limit of 15 lb. per sq. in.

SOCIETE D'ELECTRICITE of Paris has recently placed a contract with Escher Wyss & Co. of Zurich for two 5800-hp. steam turbines required in connection with the extension of the power station at St. Denis. The new machines are to be designed to operate with steam at a pressure of 770 lb. per sq. in. and at a temperature of 840 deg. F.

Electric Drive for Coal and Ash Gates

RAPID LOADING of transfer cars or railroad cars with coal or ash discharged from bunkers or hoppers often requires a series of gates with large openings. To operate its standard gates electrically in such cases, the electric screw drive gate, roller type, Fig. 1, has recently been developed by Beaumont Mfg. Co., Philadelphia, Pa., and designed so that all moving parts are protected from dirt.

This gate is designed as a self-contained unit, the rail tracks of the gate being extended to support the

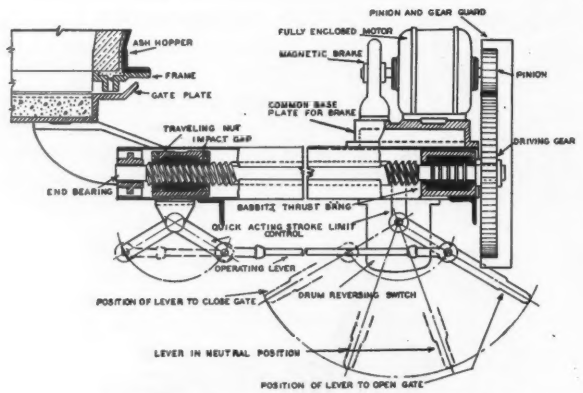


FIG. 1. DETAILS OF ELECTRIC DRIVE FOR COAL AND ASH GATES

screw drive unit. Screw housing consists of a pair of inverted channels supported from the T rail gate tracks, with shims between rail and housing support to insure proper alinement of the drive unit with the gate. The drive screw, of steel with Acme triple thread, is journaled and supported at the gate end by a cast-iron babbited bearing with grease groove and Alemite fitting. The drive end of the screw, carrying five thrust rings, is supported by a cast-steel babbited thrust bearing, also provided with grease grooves and Alemite fitting.

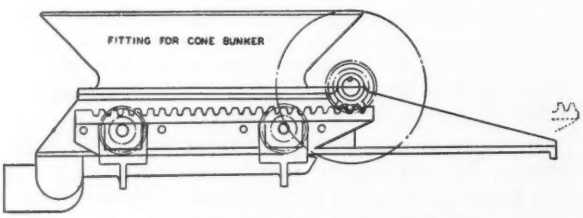


FIG. 2. ROLLER SLIDE BUNKER GATE

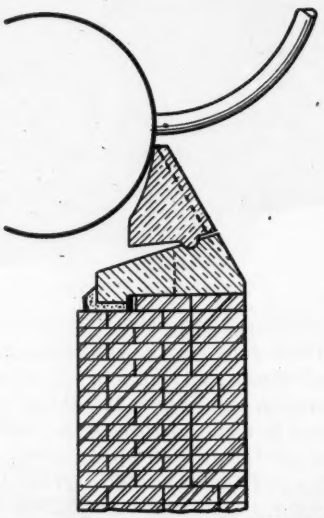
A high-torque, alternating-current motor with magnetic brake, both mounted on a common baseplate, drives the screw. A cast-steel babbited traveling nut in a cast-steel housing driven by the screw moves the gate back and forth as required through a floating connection to eliminate binding. Between the traveling nut and its housing is an impact gap to allow the screw to start before it makes contact with the housing and thus to provide a sudden impact to insure gate movement at all times. The gate is designed to be operated either by standard push-button control through magnetic contactors or by a drum reversing switch with hand lever or pull rope.

Another recent development of this company is the roller slide bunker gate, Fig. 2, designed for use on coal and ash bunkers where an easy-operating, shallow, nonclogging water-tight drained gate is desired. It is designed to operate without counterweights to make it easy to open and allow it to stay in any position without holding. It is made for low headroom and with a shallow body to prevent arching and clogging of material. A drain at the end of the gate is provided to carry off water.

These gates are designed to be especially applicable to ash or coal hoppers in which the material has been wet, to eliminate dripping of water on equipment below and to allow the bunkers to serve as drainage points for the system, especially where bunkers are filled from under-water coal storage.

Bridge Wall Seal

BRIDGE WALL SEAL, designed to make possible an air tight seal between mud drum and bridge wall of bent tube boilers, to prevent air leakage and short circuiting of gases, is shown herewith. This seal



BRIDGE WALL SEAL CONSISTS OF TWO BASIC SHAPES OF FIREBRICKS

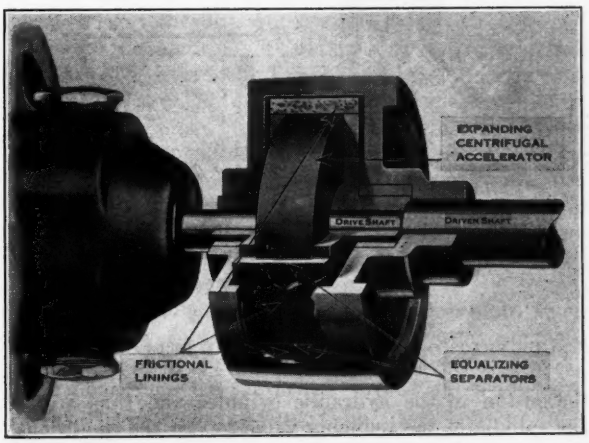
consists of two basic shapes of fire brick; all other necessary shapes are the same except that they have right and left overlapping side flanges to prevent gas leakage.

One shape is made the depth of the bridge wall and rests on it. This seal section has a shoulder that passes over the flange of the channel to hold it in place. A depression in the upper face of the lower block forms a bearing into which fits a semi-circular half-section projecting from the upper block that leans against the drum.

Rotation around the axis formed permits the block to follow movement of the drum, it is stated, and as most of the weight is on the drum side of the center of rotation, contact will be maintained as the block follows the movement of the drum. This bridge wall seal is a product of Michael Liptak, 1603 University Ave., St. Paul, Minn.

Lombard Automatic Starter

FOR REDUCING starting load requirements and for absorbing shocks and vibrations, the Lombard automatic starter shown here has recently been developed by the Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass. The purpose of the starter, which is placed between driving and driven machines, is to allow the driving machine, such as a motor, to attain full working speed at once, while the driven



SECTION OF LOMBARD AUTOMATIC STARTER

machine comes up to speed more gradually. This permits the motor to be selected for actual running load, it is stated.

To accomplish this, the starter employs an expanding centrifugal accelerator containing a fluid to give automatically the necessary pressure. The fluid is usually mercury for the smaller sizes and water for the larger, the accelerator being permanently sealed.

When the starter is at rest, the fluid is in the lower part of the accelerator. As rotation starts, an interval of time is required before it becomes uniformly distributed around the inside of the accelerator. When this occurs, the driving pressure is applied to the driven machine, the gradual building-up of the pressure producing a gradual acceleration of the driven machine. The pick-up interval, it is stated, may be fixed to suit the conditions.

The starter is designed to operate vertically or horizontally. It can be arranged for direct connection or for gear, chain V-belt or flat belt drives. There is no limit, it is stated, to the amount of power for which it can be designed.

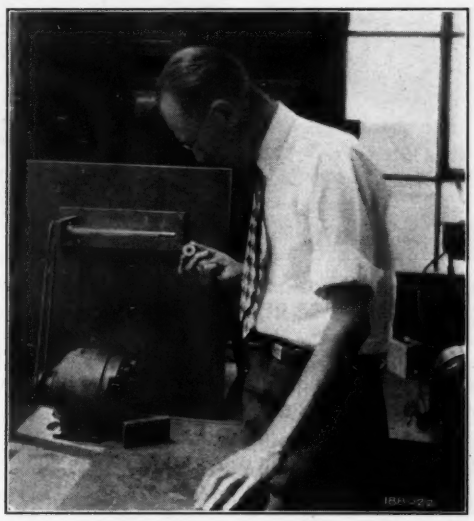
Self-Lubricating Bearing Metal

NEW BEARING METAL in the form of a self-lubricating bearing has been invented by W. C. Wilharm of the Westinghouse Research Laboratories. It has been claimed that these bearings are ten times as efficient as the "oil-less" bearings in use today. Practically all bearings of this kind are mounted without oil or grease in motors which turn only a few revolutions, and then are idle for a considerable time. Automobile starting motors consume most of the output.

This new bearing is designed also to be used with lubricant instead of the present oil-requiring bearing materials. If the supply, or film, of lubricant should for any reason become inadequate, this bearing, it is claimed, is capable of resisting the heat action of friction for a considerable length of time by means of its own lubricating qualities.

This new bearing is the result of tests in the Westinghouse Research Laboratories to determine what materials reduce friction most. When these were discovered, it was found that they could not be incorporated in an oil. Therefore, they were put in the bearing itself.

The bearing is made by mixing one or more metallic powders with one or more materials yielding a soapy substance. The ingredients are put in a cold mold and subjected to a pressure of approximately 40,000 lb. per sq. in. The temperature is gradually raised until it reaches about 400 deg. F. After keeping the mold at



W. C. WILHARM, OF THE WESTINGHOUSE RESEARCH LABORATORIES, WITH HIS SELF-LUBRICATING BEARING

this temperature for half an hour, the pressure is raised to 200,000 lb. per sq. in. The pressure is then released and the mold allowed to cool. After this, the bearing is removed from the mold.

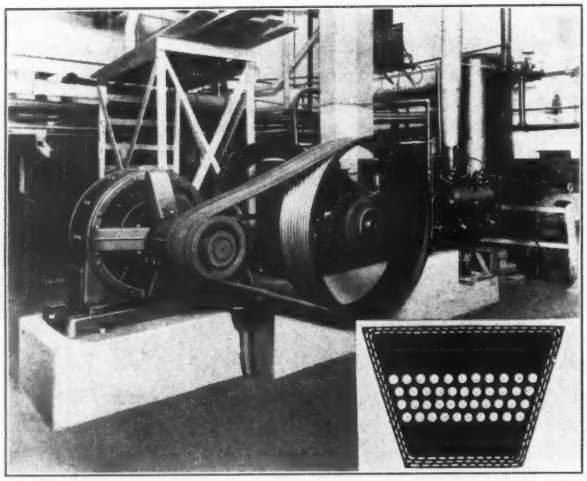
Bearings made of this new material can either be made to certain specifications according to the mold used or they can be made in blank and machined to the size desired.

THAT THERE is always a better way to do the job and that workmen are showing keen interest in trying to find that better way is indicated by a report of the General Electric Co., showing that for the first six months of this year $56,974 was paid to employes for suggestions of plans to improve their jobs. For the first half of the present year, a total of 17,474 suggestions were made and 5616 were adopted, as compared with 13,200 suggestions offered the first six months of 1929 and an adoption of 3953 for which $49,586 was paid employes.

WITH CHAIN GRATE stokers it is better to run a thick fire slowly than a thin fire rapidly.

Multi-V-Drive

MULTI-V-DRIVE consisting of a number of endless molded V-belts running in V-grooved sheaves, as shown has recently been placed on the market by Worthington Pump & Machinery Corp., Harrison, N. J. This drive developed in conjunction with the Goodyear Tire & Rubber Co., uses the latter company's Emerald Cord belts in which the load-carrying members are high-grade cotton cords arranged in parallel lines and concentrated about the neutral axis. Each sheave is carefully grooved, machined and finished so that they will present a smooth surface on which the belts run.



AN INSTALLATION OF THE MULTI-V-DRIVE. INSERT, CROSS-SECTION OF THE MOLDED V-BELT

Claims made for this drive are: high efficiency, long life, low maintenance, quiet operation, small floor space and high speed ratios.

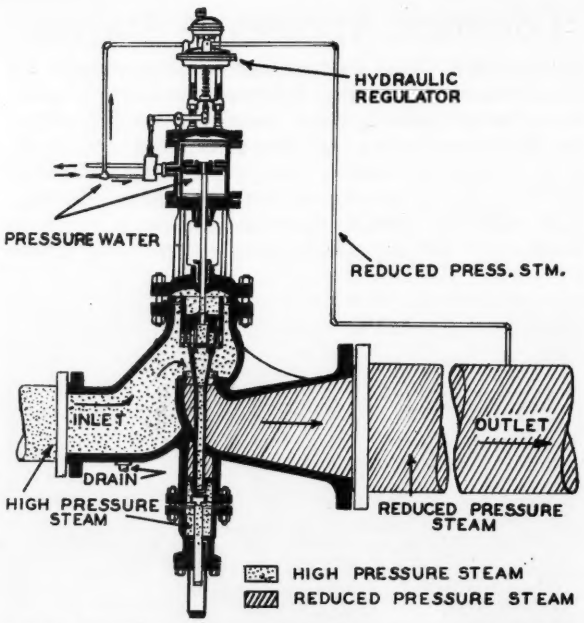
Balanced Venturi Reducing Valve

SINGLE-SEATED balanced venturi reducing valve with self-contained hydraulic regulator, shown herewith, has recently been developed by Schutte & Koerting Co., Philadelphia, Pa. It is designed for working pressure from 250 lb. up to 450 lb. and is recommended for installations where a tight seating valve is required.

To secure accurate pressure regulation on the outlet side, a tapered disc having a long travel is used. This disc is hollow and has a pilot valve to admit steam to the under side of the bottom piston. This arrangement is designed to balance the valve so that it will require little power to actuate the spindle.

Valve spindle is connected to a piston moving in a cylinder on the valve yoke. This piston is operated by water pressure above or below it, controlled by a pilot valve, the spindle of which is connected to the hydraulic regulator.

Water at 30 lb. pressure is admitted to the regulator; a connection from the regulator to the low-pressure header is led to the regulator so that any variation in pressure at this point on the header will cause the regulator to actuate the pilot valve, regulate the motion of the piston in the hydraulic cylinder and thus adjust the spindle of the reducing valve to suit the conditions. It is claimed that with this valve the reduced pressure can be maintained within limits as small as 0.5 per cent of the inlet pressure.

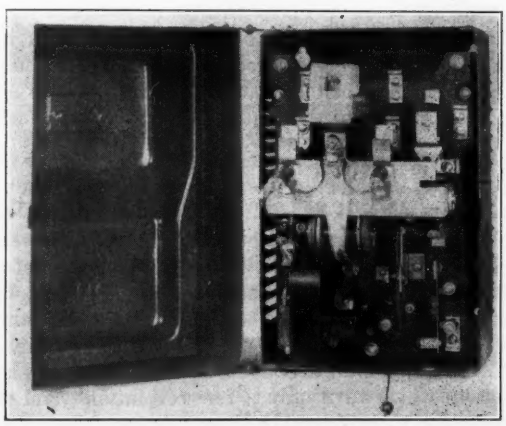


SINGLE-SEATED BALANCED VENTURI REDUCING VALVE

The reducing valve is made in sizes from 2 in., capacity 8000 lb. steam an hour to 12 in., 288,000 lb. steam an hour based on steam at 400 lb., 700 deg. and reducing it to 150 lb.

New Design of Timestarter

WESTINGHOUSE ELECTRIC & Manufacturing Co. announces the Class 8512 Timestarters, a complete line of remote-controlled, magnetic starters for constant and adjustable speed direct-current motors in sizes up to 10 hp., 230 v. They provide 3 points of definite time limit acceleration, permitting safe and accurate starting of the motor under full or partial load.



NEW TIMESTARTER FOR ADJUSTABLE SPEED MOTORS, PROVIDES OVERLOAD PROTECTION, DYNAMIC BRAKING, AND FULL FIELD STARTING

Four combinations of these starters make them applicable to a wide range of uses in industrial and building applications. Class 8512-A, for constant speed motors, does not provide overload protection nor dynamic braking. Class 8512-B, for constant speed motors, provides thermal relay overload protection but not dynamic braking. Class 8512-C, for constant speed motors, provides the overload protection and dynamic braking. Class 8512-F, adjustable speed motors, provides overload protection, dynamic braking and full field starting.

The complete line of timestarters is of standardized construction; the different combinations are made possible by the addition of certain parts to a standard chassis. The standard chassis consists essentially of a three-point accelerating contactor, mechanically connected to an ingenious escapement mechanism. These are mounted as a unit on a tough molded insulating base. Bobbin type resistors, mounted on the rear of this unit provide the necessary resistance between points of acceleration. The chassis is enclosed in a ventilated, sheet steel cabinet and is readily removed from same by loosening three screws.

Definite time limit acceleration is obtained in starting by delayed action of the accelerating contacts, brought about by an escapement mechanism.

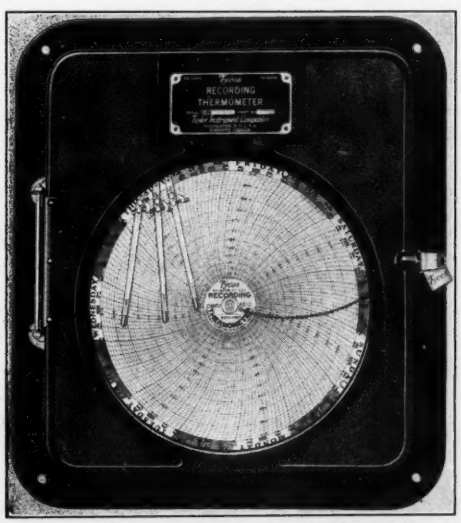
Inverse time limit overload protection is provided by the overload relay, arranged for either hand or automatic reset.

Either low-voltage protection or low-voltage release may be obtained depending on the type of master switch used.

Flush-Mounted Gages

FLUSH-MOUNTED recording thermometers and recording pressure gages, designed for panel board mountings, have recently been placed on the market by Taylor Instrument Companies, Rochester, N. Y.

It can be supplied with one, two or three pens. The case is an aluminum casting, fiurnished in dull instrument black. The instrument is back connected with the tube system designed to be removed from the front. To provide a moisture-and-dust-tight joint, the door is mounted on spring hinges. Micrometer pen adjustment is used to permit accurate adjustment of the pen arm, while a pen lifter is provided to allow change of chart without spilling ink from the pen. Chart ejector is installed to facilitate chart removal, pens are suspended on stainles steel pen arms and a specially-designed clock is used with three-point mounting and clock starter.



FLUSH MOUNTED RECORDING THERMOMETERS AND PRESSURE GAGES

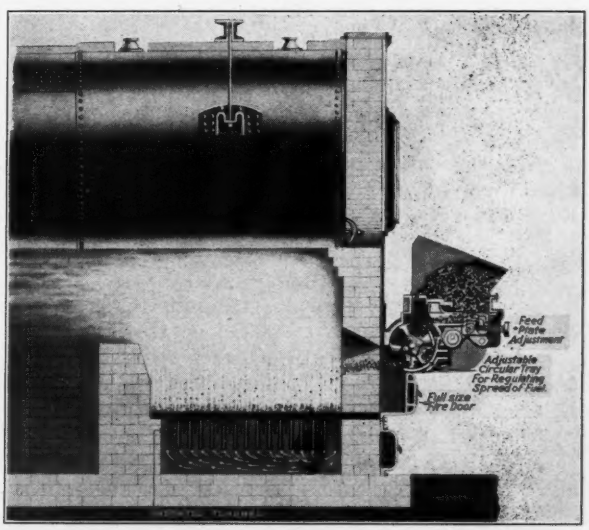
New Automatic Stoker

FIRITE AUTOMATIC STOKER, designed to burn all types of fuel such as coke breeze, anthracite, bituminous and lignite, has recently been placed on the market by Hoffman Combustion Engineering Co., Detroit, Mich. Construction of the unit is as shown. The stoker body is designed for mounting directly on the boiler front without obstructing any hand feed doors that may be present.

Directly beneath the hopper is the feed plate, to which a reciprocating motion is imparted by a cam arrangement driven through steel cut gears. This is intended to feed coal over the edge so that it will be deposited on the curved adjustable throat piece. The revolving distributor blades are designed to pick it up here and to distribute it evenly and continuously over the entire grate area.

With the object of reducing excess air to a minimum, combustion air is introduced below the grate so that it will be preheated. The air is conducted to the fire through a tuyere arrangement as shown consisting of a number of tubes the upper ends of which are designed to produce a crisscrossing of the air jets and to promote even air distribution over the entire grate area.

Steel distributor blades are designed to be held out by centrifugal force when in operation and are not rigid, so that they will provide a clearance space of 3.5 in. in case of obstruction. The feed plate can be adjusted for varying loads, while the speed of the distributor blades remains constant. The unit is equipped throughout with roller bearings and special ground high-carbon steel shafting. Distributor blade shaft bearings, exposed to radiant heat, are water-cooled.



DETAILS OF INSTALLATION OF A FIRITE STOKER

National Exposition of Power and Mechanical Engineering

DETAILS of the ninth Exposition are well under way under the leadership of I. E. Moultrop, chairman. It will be held in Grand Central Palace, New York, December 1 to 6, during the same week as the annual meeting of the American Society of Mechanical Engineers and of the American Society of Refrigerating Engineers.

Large attendance is expected because business executives feel the need of keeping posted on methods and equipment to secure maximum economy under the present urge for reduction in production and operating expense.

Importance of power in our present day life is indicated by the burning of 42,000,000 t. of coal a year in utility power plants. Of this, only 973,000 t. is fired by hand or on open grates, the balance being handled by stokers or as pulverized fuel, which shows the predominance of the use of advanced methods and equipment such as will be demonstrated at the Exhibition.

New and improved devices which have been developed during the past year by manufacturers, while the rush to fill orders for product has been relieved, will be presented for the first time at a show. At present over 400 spaces have been taken with reservations still coming in. The fact that no exhibition will be held in New York in 1931 has influenced exhibitors to give special attention this year to producing a comprehensive display which will attract large numbers of visitors.

Large, heavy units will be much in evidence, both stoker and pulverized fuel burning plants being shown in full size units with all recent refinements.

Instruments for high pressures have been developing rapidly so that new designs to meet modern demands will be prominent. With plants burning hundreds of tons of fuel, the importance of knowing operating conditions and results is appreciated, hence proper equipment of instruments has become a vital consideration.

Air conditioning and control are proving of aid in improving quality and output of product in many industries. Equipment for such purposes will, accordingly, receive a large share of attention, including air supply for boiler furnaces.

Boiler development, special alloy steel for boilers, advances in design and construction for piping systems, boiler-room accessories for control of air, fuel, water and their handling will be prominent at the Exhibition.

Arrangements are in the hands of the International Exposition Co., Grand Central Palace, N. Y., Charles F. Roth, manager.

Small Pipe Machine

TOM THUMB PIPE MACHINE, claimed to be the smallest complete pipe machine yet placed on the market, has just been announced by the Oster Manufacturing Co. and the Williams Tool Corp. of Cleveland, Ohio, and Erie, Pa.

The machine is designed to cut-off, thread, ream and chamfer all sizes of pipe from ¼ to 1¼ in. size; its overall dimensions are 18½ in. height, 16 in. wide and 23½ in. deep. Included in these dimensions is the ½-hp. Domestic Electric Universal motor, designed automatically to adjust its speed to the pull on the dies. According to the manufacturers, tests have been made which show that the Tom Thumb pipe machine will put a standard thread on a 1¼-in. pipe in 18 sec. and on a ¼-in. pipe in 12 sec.

The pipe machine was designed and built for the average plumbing shop; however, a special bolt chuck has been designed for use with the machine, to thread bolts from ⅜ to 1½ in.

It is claimed that the machine is unusually quiet and smooth in operation, the motor power being transmitted to the machine by a double V belt. The machine is built of heavy, close-grained cast iron and uses Timken Roller Bearings throughout. It is equipped with a cutting-off and reaming attachment and a reversible snap switch.

Battledeck Floor Construction

WORK IS NOW being completed on the Berkshire Garage at Pittsfield, Mass., which contains one of the largest areas of battledeck floor so far constructed since this particular system was first advocated by the American Institute of Steel Construction, according to a recent announcement by the Institute. Lighter, stronger, safer and more efficient and economical buildings are assured by this floor, it is claimed. The building is being erected for the Berkshire Auto Co. of Pittsfield from plans by George E. Haynes, architect. The structural steel was fabricated, erected and welded by the Haarmann Steel Co. of Holyoke, Mass., and General Electric Co. welding equipment was used throughout.

AUTOMATIC MACHINE WELDING PLATES TO BEAMS ON BATTLEDECK FLOOR

The photograph shows the automatic machine welding the steel plates to the beams. There are approximately 8500 sq. ft. in this floor and there will be no covering on the steel plates. The floor consists of steel plates ¼ in. thick and 24 in. wide, welded to 5-in. I-beams. The average span is 20 ft. The safe maximum uniform distributed load is 135 lb. per sq. ft., the floor itself weighing 15.2 lb. per sq. ft.

NEW CONCERN has just been organized in Basel, Switzerland, under the auspices of the Siemens-Schuckert Works Co. and the A.E.G. of Berlin, the Augsburg-Nuremburg Maschinenfabrik and the Brown-Boveri Co. of Baden and Mannheim, with the title of the International Ljungstrom Union Co. and a nominal capital of $200,000 to develop under license from the Swedish Ljungstrom Co. the construction and use of Ljungstrom turbines in Germany and Switzerland.

News Notes

GORDON F. DAGGETT of Milwaukee, Wis., is to represent the Stephens-Adamson Mfg. Co. of Aurora, Ill., handling its machinery for the entire state of Wisconsin. He will be located at 735 Briarwood Place, Milwaukee.

Mr. Daggett handled the Minnesota-Wisconsin boundary line survey, in which the line between the cities of Duluth and Superior was reestablished and millions of dollars worth of dock and wharf improvements were reassessed under Supreme Court order.

He is a University of Wisconsin graduate, a member of the American Society of Civil Engineers and the Engineering Society of Wisconsin. His early training was gained in several power projects on the west coast. The last fifteen years have been spent in private practice and in various positions on the Wisconsin Highway Commission at Madison and later as executive secretary for the Wisconsin Mineral Aggregate Association.

FIVE WATERWHEELS furnishing 750 hp. at the Oregon, Ill., plant of the Illinois Northern Utilities power plant were destroyed by flames which swept the one-story structure early the morning of Aug. 29, causing $20,000 loss, it is reported. The loss is partly covered by insurance. Officials said the plant would be rebuilt immediately.

B. H. MAC NEAL has been appointed Southern district manager of the Crane-Shovel-Dragline Division of Link-Belt Co., Chicago. He will have his headquarters at the company's Birmingham office and will have charge of the territory between the Mississippi Valley and the East Coast, south of and including the states of Tennessee and North Carolina.

AFTER OCTOBER 1, 1930, the general office and main sales office (exclusive of sales of special drop-forgings to order) of J. H. Williams & Co. of Buffalo, N. Y., will be consolidated with its present eastern sales office and warehouse at 75 Spring Street, New York City. A service department will be retained at Buffalo to represent the sales department at the factory.

MARTIN VAN STAPPEN has been appointed sales manager of the industrial blowers and turbine department of Coppus Engineering Corp., Worcester, Mass. Ernest Kundig has been appointed sales manager of the house heating blower department, as well as export manager of the company. Mr. Bolle, formerly the sales manager, is no longer connected with the company.

GEORGE L. KNIGHT, mechanical engineer of the Brooklyn Edison Co., was tendered a dinner on the night of Sept. 10, by more than 150 employes of the mechanical engineer's department of the company. The dinner was in celebration of Mr. Knight's completion of 25 yr. service with the company. He was presented with an engraved gold watch.

Mr. Knight received an Electrical Engineering Degree from Drexel Institute in 1900. On September 10, 1905, he came to The Brooklyn Edison Co. from The New York Edison Co. where he had been chief draftsman of the Waterside Station. He assumed similar duties in The Brooklyn Edison Co. until 1908 when he became designing engineer in charge of all design and building construction. In 1923 he was appointed mechanical engineer in charge of mechanical and civil engineering design and construction. In 1922 he was made Chairman of the Engineering Committee, responsible for the design and construction of the Hudson Ave. generating station.

Mr. Knight is a past president of the Brooklyn Engineers Club. He was a manager of the American Institute of Electrical Engineers from 1922 to 1925 and was vice president of that organization for two years from 1926. He is a trustee of Engineering Foundation, Inc. He is also a member of the American Society of Mechanical Engineers, New York Engineers Club and the Crescent Athletic Club.

TWO LARGE ORDERS have recently been received by the Westinghouse Electric and Manufacturing Co. for Visicode type supervisory control equipment. These orders cover a total of 25 Visicode equipments, 5 having been purchased by the Long Island Railroad Co. and 20 by the Reading Co. In addition, both of these orders include the switchboards for the main stations involved. The Visicode equipment is designed to provide a means for remotely controlling and supervising a large variety of power apparatus, with continuous individual visual lamp indications for each piece of remotely controlled apparatus, all over only two telephone type line wires. Where a number of the stations are in the same general direction from the dispatching point, such as on the orders just secured, these stations are arranged to operate over the same pair of line wires.

The Reading Co. order covers equipment for the initial railway electrification of its Philadelphia suburban area. The Long Island Railroad Co. order covers Visicode type of supervisory control for five substations.

CARBONDALE MACHINE CO. announces the removal of its offices to 325 West Huron St., Chicago, Ill.

L. J. WING MFG. CO., New York City, announces the appointment of the Harry G. Murphy Sales Co., 316 Union National Bank Bldg., Scranton, Pa., as sales representative for northeastern Pennsylvania.

NEW CONSTRUCTION in transmission belting is announced by Cincinnati Rubber Mfg. Co., Cincinnati, Ohio. This new belt, called Cincinnatus Duoflex, is designed to give greater pulley contact thus delivering more horsepower. It is built to fit all kinds of pulleys, flat or heavy crowned, large or small. Close pulley hug is obtained, it is claimed, by an automobile tire cord insert giving crosswise flexibility and adhesion under the seam.

L. L. MACHIA, in charge of oil field sales of the Climax Engineering Co., of Clinton, Iowa, and Chicago, has changed his headquarters from Clinton, Iowa, to Fort Worth, Texas. Forest Dunlap has been placed in charge of Kansas, Oklahoma and Arkansas sales, with headquarters at Tulsa, Okla. F. E. Blanchard, in charge of dealers and service parts organizations and the power unit division, has taken up headquarters at the company's main office in Chicago.

YEOMANS BROTHERS CO., Chicago, Ill., has recently appointed C. Calor Mota as its exclusive representative in Porto Rico, with offices in Mayaguez, Porto Rico.

BYLLESBY ENGINEERING AND MANAGEMENT CORP. announces that The California Oregon Power Co. has been authorized by the Federal Power Commission to construct a hydroelectric project on the Klamath River in Oregon. Construction work on the first unit of approximately 50,000 hp. will be started as soon as other necessary arrangements can be made.

L. A. LANKIE, manager of the Charles City, Iowa, Gas Co. for the past three years, has been made division manager for the Northwest Illinois Utilities, with headquarters in Savannah, Ill. The Charles City plant will continue under his supervision; it is owned by the Federal Public Service Co., subsidiary of the larger company.

E. A. WHITNEY, who has been connected with the A. P. Green Fire Brick Co. for 13 yr., for the last three years as manager of the specialty department, has resigned to take the same position with the Mexico Refractories Co., Mexico, Mo.

BAILEY METER CO., Cleveland, Ohio, announces the opening of a branch office in Denver, Colo. M. E. Reddick has been appointed manager of this branch office, which is located at 2370 Dahlia Ave.

FOSTER WHEELER CORP., 165 Broadway, New York City, announces the opening of a branch office at 712 Thompson Bldg., Tulsa, Okla., in charge of C. C. Steward.

Books and Catalogs

TECHNICAL EQUIVALENT DICTIONARY in English, German and Italian is published by Hubert Hermanns of Berlin. It is arranged in three sections, having German, English and Italian as the index words, with equivalents in the other two languages following in each case. The assumption is that the user knows the meaning of the word in one of the three languages and makes simply its equivalent in the desired language. It covers all branches of engineering and includes shop and trade firms as well as the more usual words, giving several equivalents where they are in common use. It can be had through book stores, price $3.75.

HYDROVAC DUST HANDLING SYSTEM, designed to remove dust, soot, fly-ash, siftings and the like from collecting hoppers is described and illustrated in a recent bulletin by Allen-Sherman-Hoff Co., Philadelphia, Pa. Wind-swept valves and Coghlan type hydrovactors are used; the bulletin discusses them in detail and brings out the operating advantages of the system.

PNEUMATIC ash removal equipment for small plants is described in a bulletin issued by Allen Air Appliance Co., Inc., of 452 Lexington Ave., New York, N. Y.

STEPHENS-ADAMSON MFG. CO., Aurora, Ill., have just published a folder describing a new type of feeder, designed primarily to handle abrasive bulk materials in large tonnages. The folder contains installation photographs, tables of capacities, dimensions and building clearances, also details of construction.

NEW BULLETIN, No. 20,490, describing the application and construction of Type CW wound rotor induction motors has been published by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. These motors have a wide application range for driving pumps and compressors and for other constant and varying speed, continuous duty services. They are used with belted, coupled or geared drives and are adaptable where high starting torques and low starting currents are required.

Power Plant Construction News

Ala., Mobile—The Standard Oil Co. of Louisiana, Inc., 2134 St. Charles Avenue, New Orleans, La., plans installation of electric power equipment in proposed oil storage and distributing terminal at Mobile, entire project reported to cost over $350,000.

Ark., Bentonville—The Bentonville Ice & Cold Storage Co. plans rebuilding of portion of ice-manufacturing and cold storage plant recently destroyed by fire with loss reported at over $50,000, with equipment.

Calif., Brawley—The Inland Empire Gas Co., El Centro, Calif., is planning the early construction of an artificial gas manufacturing plant at Brawley, reported to cost over $85,000.

Calif., Pasadena—The Pasadena Municipal Light Department, has authorized an immediate call for bids for proposed one-story addition, 100 x 150 ft., to municipal electric light and power plant to cost about $150,000. Bennett & Haskett, First Trust Building, Pasadena, are architects.

Calif., San Francisco—The General Petroleum Corporation, 310 Samson Street, plans installation of a boiler house, pumping machinery and other mechanical equipment, in connection with an oil storage and distributing plant in the North Beach district, entire project to cost over $750,000.

D. C., Washington—The Board of District Commissioners, District Building, is asking bids until Sept. 23, for two portable air compressor units, gasoline driven, as per specifications on file.

Ga., Augusta—The Houston Ice & Coal Co., 723 Reynolds Street, Charles G. Houston, president, has plans under way for a one-story ice-manufacturing plant on Thirteenth Street, reported to cost over $30,000, with equipment.

Ga., Blue Ridge—The Toccoa Electric Power Co., operated by the Tennessee Electric Power Co., Chattanooga, Tenn., has approved plans for a two-story and basement power plant at Blue Ridge, to cost about $85,000.

Ga., Woodbine—The Georgia Power Co., Electric Building, Atlanta, plans the construction of a transmission line from Kingsland to Woodbine.

Ill., Belleville—The Oakland Foundry Co. plans installation of electric power equipment in connection with proposed rebuilding of power house and foundry destroyed by fire Sept. 8, with loss reported over $200,000.

Ind., Richmond—The City Council has authorized a fund of $1,000,000, for a proposed addition to municipal electric light and power plant on South Eighth Street, to provide for a new unit of 15,000 kw. capacity. John Graham is chief engineer.

Iowa, Eldora—The Central States Electric Co., Cedar Rapids, Iowa, is said to be planning the construction of a hydroelectric power plant on the Iowa River, near Eldora, to cost close to $75,000.

Iowa, Fort Dodge—The Fort Dodge Gas & Electric Co. is said to be planning an expansion and improvement program in power plant and system to cost more than $400,000, with equipment.

Kans., Holton—The City Council is said to be planning an early call for bids for an addition to the municipal electric light and power plant to cost over $60,000, with equipment. Black & Veatch, Mutual Bank Building, Kansas City, Mo., are engineers.

Mass., Springfield—The United Electric Light Co., 73 State Street, has completed plans for a new coal-handling plant, with conveyor system, etc., for local steam-operated generating plant. McClintock & Craig, 458 Bridge Street, are engineers.

Miss., Jackson—The Mississippi Portland Cement Co., care of W. S. Guest, Phoenix Building, Birmingham, Ala., recently organized by Mr. Guest and associates, plans installation of electric power equipment in proposed new cement mill near Jackson, entire project reported to cost over $1,000,000. A boiler plant is projected.

Mo., St. Louis—The St. Louis Refrigerating & Cold Storage Co., 1300 Lewis Street, has filed plans for a one-story cold storage and refrigerating plant with power substation at 1304 Clark Avenue, reported to cost about $45,000.

N. J., Paterson—The Lamond & Robertson Co., 25 Branch Street, plans installation of electric power equipment in connection with proposed rebuilding of floor covering mill, recently destroyed by fire with loss reported in excess of $250,000.

N. Y., Albany—The A. P. W. Paper Co., Albany, is said to be planning installation of electric power equipment in connection with an expansion and improvement program to double present capacity, entire project to cost over $200,000.

N. Y., Buffalo—The Buffalo Foundry & Machine Co., 1543 Fillmore Street, has filed plans for a one-story addition to boiler plant.

N. Y., Buffalo—The Buffalo Market Terminal, 1420-1502 Clinton Street, has filed plans for a new public market building to cost about $750,000, to include installation of cold storage and refrigerating equipment, electric power equipment and other mechanical apparatus.

N. D., Oberon—The Oberon Farmers' Grain Elevator Co., Oberon, is said to be planning the installation of electric power equipment in connection with proposed rebuilding of grain elevator and feed mill, recently destroyed by fire with loss reported in excess of $80,000.

Ohio, Cincinnati—The Gulf Refining Co., Frick Annex, Pittsburgh, Pa., plans installation of electric power equipment in proposed new oil refinery in the vicinity of Cincinnati, entire project to cost over $1,000,000. A boiler plant will be built.

Ohio, Cleveland—The Otis Steel Co., Riverview Avenue, plans installation of electric power equipment in proposed new continuous strip and plate mill, entire project reported to cost more than $400,000. E. J. Kulas is president.

Pa., Philadelphia—E. Sutro & Son Co., East Thompson Street, has filed plans for a one-story power plant at its hosiery mill, reported to cost about $24,000, with equipment. Mensing & Co., Presser Building, are engineers.

Pa., Pittsburgh—The Duquesne Baking Co., 223 Auburn Street, plans installation of power equipment, in connection with proposed rebuilding of baking plant, recently destroyed by fiire with loss reported over $100,000.

Pa., Spring Grove—The P. H. Glatfelter Co., will proceed with the construction of a new one-story power plant at local paper mill, for which plans have been approved, reported to cost over $50,000, with equipment.

S. D., Quinn—Earl Bronson, Quinn, and associates have secured a local light and power franchise and plan early installation of a power plant and distributing system, entire project reported to cost over $75,000.

Tenn., Memphis—The Board of Water Commissioners, Memphis, is said to be planning a new pumping plant for the municipal water system to cost over $1,000,000, with equipment.

Tenn., Memphis—The Memphis Power & Light Co., Memphis, is considering the construction of a new steam-operated electric generating plant to cost close to $1,000,000, with transmission lines.

Tenn., Nashville—The Nashville Cold Storage Co. has taken over property at 1101 First Avenue, North, and will remodel and equip for a new cold storage and refrigerating plant.

Texas, Brownsville—The City Council is arranging an immediate call for bids for a filtration plant for the municipal waterworks, estimated to cost about $125,000.

Va., Hopewell—The Southside Marketing & Finance Corporation, 151 Halifax Street, Petersburg, is considering the construction of a one-story cold storage and refrigerating plant at Hopewell, reported to cost close to $40,000, with equipment. B. F. Harris is president.

Wash., Olympia—The Board of Port Commissioners, Olympia, is said to have plans maturing for the first unit of a new cold storage and refrigerating plant on Capital Way, to cost about $100,000, with machinery. It is proposed to build additional units at a later date with ultimate investment of about $400,000. Ernest Cribble is manager.

W. Va., Pennsboro—The Pennsboro Ice & Power Co. plans rebuilding of portion of plant, recently destroyed by fire with loss reported over $25,000, including equipment.